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FY 1970 PROGRAM PLANNING ACTIVITIES

November 1, 1968

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HOUSTON, TEXAS

Bellcomm, Inc.

FY 1970 PROGRAM PLANNING ACTIVITIES

November 1, 1968

J. E. Volonte
M. M. Cutler
J. P. Jamison
H. H. McAdams
W. J. McKune
C. P. Witze

Work performed for Manned Space Flight, National Aeronautics and Space Administration under Contract NASw-417.

ABSTRACT

As assistance to NASA Planning System activities to develop the FY70 Program and to lay the groundwork for longer-term Agency planning: (1) the program rationale and approach (goals, objectives, strategies, alternative missions/projects, issues, resource requirements and planning launch schedules) developed by the disciplinary Program Category Working Groups are reviewed to determine omissions, inconsistencies and errors; (2) interfaces (program, system and mission) between and among Program Categories are identified; (3) three Agency strategies ("Conquest of Space," "Balanced," and "Returns of Space Activity") defined as spanning the spectrum of options available at the funding levels being considered ($3.5, 3.8 and 4.1 billion/year) are elaborated upon; (4) nine program alternatives are synthesized, using the NASA FY69 Interim Operating Budget with a runout of $3.68 billion in FY70 as a point of departure and adjusting the Program Memorandum options as necessary to support the strategies at the specified funding levels in FY70; (5) the program alternatives are characterized in terms of program accomplishments and programmatic factors to highlight the comparative properties of interest to management; (6) the costing methodologies used by the Program Category Working Groups are identified; and (7) the minutes of the meetings of the Planning Steering and Planning Coordination Groups are compiled.

PREFACE

This report documents Bellcomm's assistance to NASA Planning System activities in 1968.

The NASA Planning System was introduced to assist the Administrator in the development of the FY70 Program and Budget submission to the Bureau of the Budget and to lay the groundwork for longer-term Agency planning. The activities were conducted as follows:

- The Planning Steering Group (PSG), chaired by the Associate Administrator of NASA and supported by the Planning Coordination Group, directed the activity.

- The PSG Synthesis Group, a sub-group of the PSG, synthesized overall agency programs and developed agency strategies.

- The Program Category Working Groups, in the following disciplinary areas generated the basic program alternatives for the planning system: Extension of Manned Space Flight Capability, Lunar Exploration, Planetary Exploration, Astronomy, Space Physics, Space Biology, Space Applications, Aircraft Technology, Advanced Space Technology, and Supporting Activities.

- Bellcomm and the Mission Analysis Division of OART also participated in the synthesis activities.

Bellcomm participation has been carried out principally through:

- Attendance and presentations at meetings of the PSG and PCG.

- Attendance at working sessions of the PSG Synthesis Group.

- Membership on Program Category Working Groups and Sub-Groups.

- Analysis of data developed by the Working Groups for their respective Program Memoranda.

- Analysis and synthesis activity in connection with PSG/PCG development of Agency strategies and program alternatives.

- Special study of Program Category costing methodologies.

During the planning cycle Bellcomm submitted to the Chairman, PSG, drafts of the chapters in this report and observations with respect to the planning process.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Tables and figures are on unnumbered pages at the ends of the chapters and appendixes with which they are associated and in the order shown below. The number of the table or figure indicates the chapter or appendix assignment.

LIST OF TABLES AND FIGURES (CONT'D.)

Chapter 1
Summary

Chapter 1

SUMMARY

1.0 Introduction

This chapter summarizes the results of the following activities which were carried out as assistance to the NASA Planning System and which are described in detail in the report chapters indicated:

- Identification of and commentary on program rationale and approach - Chapter 2.
- Identification of program category interfaces - Chapter 3.
- Elaboration upon NASA program strategies - Chapter 4.
- Synthesis of NASA program alternatives - Chapter 5.
- Characterization of alternative programs - Chapter 6.

In this summary chapter reference is made to the tables, figures, and other compilations in Chapters 2 through 6.

1.1 Program Rationale and Approach

The rationale and approach determined by the Program Category Working Groups for each of the Program Categories are set forth in individual tabulations in Table 2-1, which covers (1) the program goals and next objectives, (2) the strategies considered to achieve the objectives, (3) the alternative missions or projects considered to implement each strategy, (4) the internal issues faced in preparing the FY70 program, and (5) the resource requirements and planning launch schedules for each program option developed. The funding requirements are presented in terms of the Baseline Program, derived from the "FY 1969 Interim Operating Budget with Runout Implications" distributed by the Assistant Administrator for Administration's memorandum of August 16, 1968.

Omissions, inconsistencies and errors in the statements of rationale and approach are identified for each Program Category. The principal comments applicable to more than one program can be summarized:

1. Some Program Memoranda are too lengthy, with the result that descriptive material tends to obscure the elements of the rationale and approach.

2. In a number of programs the objectives are stated in open-ended form, and target dates of achievement are not indicated.

3. The handling of alternative program strategies is not entirely adequate. In some cases several strategies are identified, but with minimum elaboration, one is selected as the basis for program planning. In other cases the strategies selected are levels of funding, which is tantamount to choice of a single approach. These effects may be partly attributable to the concurrent development of Program Memoranda and synthesis of Agency program alternatives.

4. The treatment of issues is not uniform among the Categories. In some Program Memoranda only internal issues are identified; in others, only the major issues stated by the Bureau of the Budget at the beginning of the planning cycle.

5. In some programs there is no consistent identification of projects in the various portions of the Program Memorandum. It is desirable to use the nomenclature shown in the Baseline Program in the text, as well as in the tabulations of resources requirements and of planning launch schedules.

1.2 Program Category Interfaces

Interfaces between and among the Program Categories are identified under three classifications:

Program - goals, objectives, program strategies, alternative missions/projects, issues, resources, and schedules.

System - major elements of the flight systems and the ground test, development, and operational support systems.

Missions - mission profiles, precursory mission requirements, and requirements for flight support from other programs.

It is desirable to include two additional classifications, (1) Research and Technology and (2) Management, but the Program Memoranda generally do not provide sufficient information to permit meaningful identification of interfaces in these areas.

Figure 3-1 presents a summary of the interfaces identified. The elements which serve as the basis for interfaces among more than two Program Categories are listed in Section 3.9.

1.3 NASA Program Strategies

To provide a basis for the synthesis of NASA program alternatives, three Agency strategies are defined as spanning the spectrum of options available at the Agency funding levels being considered, \$3.5, \$3.8 and \$4.1 billion/year:

- Emphasize the conquest of space, i.e., the development of capability to meet new challenges and ensure preeminence.

- Continue present balance of Agency goals.

- Emphasize the returns of space activity, i.e., the utilization of existing capability to support data-gathering in applications and science.

The characteristics of each of the strategies are outlined and elaborated upon in Table 4-2 in terms of (1) their general Agency-wide features and (2) the implementing strategies for the individual Program Categories.

Evaluation of the strategies shows that they are acceptable in that they directly support or permit attainment of all the goals selected to guide the Agency in planning its contribution toward the fulfillment of national requirements. The selected Agency goals and the national requirements with which they are associated are shown in Table 4-1. The strategies are suitable in that they offer competitive and comparable approaches. The number of program alternatives to be considered, resulting from three strategies at each of three funding levels, tends to make the program evaluation task difficult, and it appears desirable to reduce that number through imposition of additional selection criteria. Qualitatively the strategies are compatible with the Program Memoranda developed. However, except for a few cases, the Program Memoranda do not present options which are sufficiently austere to permit direct synthesis of Agency programs at the lower funding levels. In particular, simple addition of the fiscal requirements of the most austere alternative of each category yields a total of more than \$3.9 billion for FY70.

1.4 NASA Program Alternatives

Nine program alternatives, considered feasible in terms of funding, facilities and manpower requirements, are synthesized in implementation of the selected Agency strategies and funding levels. In each alternative the funding level constraint is applied directly to the FY70 Program, and the options presented by the Program Memoranda are adjusted as necessary to achieve the levels of $3.5, $3.8, and $4.1 billion in that year. In order to make maximum use of the Program Memorandum data, no effort is made to maintain a constant funding level throughout the five-year plans.

Achievement of the $3.8 billion level in the face of a FY70 Baseline total of $3.68 billion requires that new starts in that year be held to approximately $120 million. This entails slippage of new starts identified in the Program Memoranda since the minimum sum of the FY70 requirements exceeds $3.8 billion. Achievement of the $3.5 billion level also requires cancellation of decisions made in FY69 or prior years; additional cancellations are necessary to permit the introduction of new starts in FY70.

The basis for the program selected under each Category for each strategy is identified in strategy/funding Table 5-2, which is highlighted in the "strategy vector" Figure 1-1. The Agency program alternatives selected for characterization are outlined in terms of funding requirements in Tables 5-3 through 5-13 and in terms of planning launch schedules in Tables 5-14 through 5-16. Except for the funding summary in Table 5-13, funding requirements are stated as variations with respect to the Baseline Program. The nomenclature of the Baseline Program is generally used. In the case of OMSF funding, however, it was found convenient to introduce an additional category called "OMSF Common" to clarify the funding of the EMSF and Lunar Exploration Programs. The projects included in the various programs are described briefly in Appendix I.

1.5 Program Characterization

The Agency program alternatives are characterized to provide the basis for their evaluation. To highlight the comparative properties of interest to management, evaluation criteria have been defined in two major categories, Program Accomplishments and Programmatic Factors.

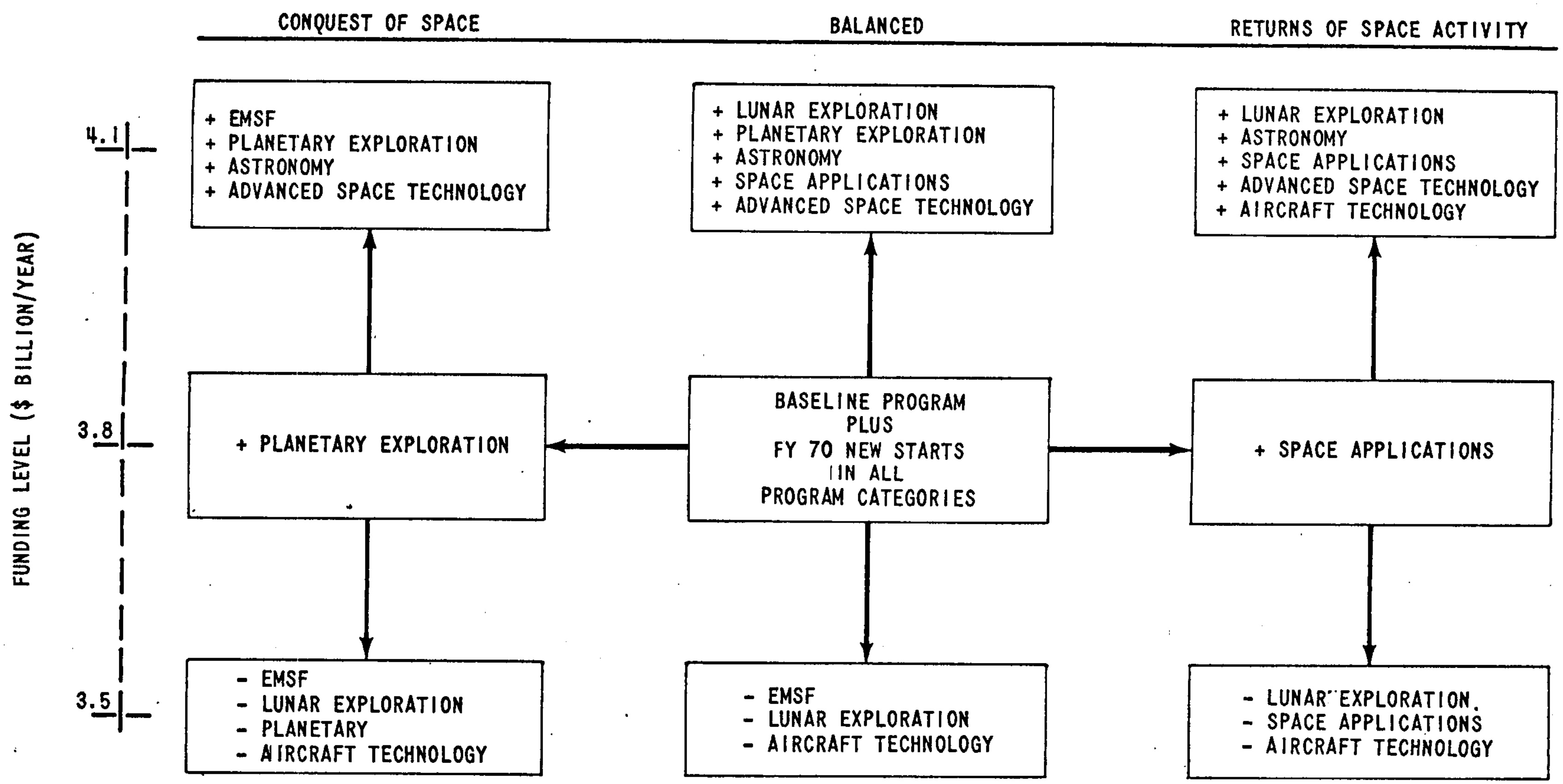
The relative worth of individual alternatives is reflected in the degree to which they accomplish the Agency's goals. In order to assess the contribution of a program towards a goal, it is necessary to understand the contributions of individual Program Categories and projects within categories. The differences in program accomplishments at the project/mission level are identified. The comparative accomplishments of the program alternatives are summarized in Tables 6-1 through 6-3.

The significant programmatic factors requiring consideration by management in evaluating a program alternative are defined as:

- Funding pattern
- Sensitivity to budget cut ($300 M/yr)
- Sensitivity to budget increase ($300 M/yr)
- Sensitivity to project/mission failure
- Sensitivity to unanticipated gain in knowledge
- Sensitivity to USSR achievement
- Maintenance of scientific, technical, and administrative base
- Continuity of space activity
- Growth potential
- Major new starts and cancellations

The foregoing factors are elaborated upon and are applied to each of the program alternatives. The characterization of the individual alternatives is summarized in Tables 6-4 through 6-6, each of which is addressed to a particular funding level.

In developing the characterization, the possibilities of quantifying the characterization data for program evaluation purposes were briefly investigated. A possible approach based on Program Accomplishments is discussed in Appendix II.



NOTES:

- + AND - INDICATE INCREASE AND DECREASE IN FUNDING, RESPECTIVELY
- ARROWS INDICATE BASE TO WHICH INCREASE OR DECREASE IS APPLIED
- ONLY PROGRAMS WITH SIGNIFICANT INCREASE OR DECREASE ARE LISTED

FIGURE I-1 STRATEGY VECTORS

Chapter 2
Rationale and Approach

Chapter 2

PROGRAM RATIONALE AND APPROACH

2.0 Introduction

This chapter outlines the rationale and approach determined by the Program Category Working Groups for each of the Program Categories selected for the NASA FY70 Program. Table 2-1 sets forth for each Category: (1) the program goals and next objectives, (2) the strategies considered to achieve the objectives, (3) the alternative missions or projects considered to implement each strategy, (4) the internal issues faced in preparing the FY70 Program,* and (5) the resource requirements and planning launch schedules for each program option developed.

Table 2-1 is based on the Program Memoranda submitted to the Planning Steering Group (PSG) on about September 3, 1968. The specific Program Memorandum used for each Category is identified in the title of the table prepared for the Category. The funding requirements are presented in terms of the Baseline Program, which is derived from the "FY 1969 Interim Operating Budget with Runout Implications" distributed by the Assistant Administrator for Administration's memorandum dated August 16, 1968. For each Category the Baseline Program is indicated for the years 1970-74, and the increments above baseline are shown for each of the program options developed. The financial data is rounded off to the nearest million dollars.

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*The major program issues identified by the Bureau of the Budget are shown in Table 2-2.

The terms used in the tabulations are defined in Section 2.1. In the succeeding sections, commentaries on the omissions, inconsistencies and errors in the statements of rationale and approach of each of the Program Categories are provided. Inconsistencies between Categories are covered in Chapter 3.

2.1 Definition of Terms

Program Goal - Open-ended, fundamental purpose of work in a Program Category.

Next Objective - Program or system milestone or significant increment of information to be achieved within a period of approximately the next five years or within the years directly affected by present planning; closed-ended with associated date of achievement where possible.

Program Strategy - A conceptual approach for achieving some or all of the next objectives.

Alternative Missions or Projects - For a particular program strategy, the alternative missions/projects or combinations of missions/projects or major systems which would implement that strategy.

Issue - A point of controversy requiring a management decision in the formulation of the FY70 program.

2.2 Commentary on Individual Programs

The omissions, inconsistencies and errors in the Table 2-1 statements of rationale and approach of each of the Program Categories are identified and discussed in the following sections.

2.2.1 Extension of Manned Space Flight Capability Program (PM dated September 3, 1968)

A. Except for the first, the objectives are generally open-ended and are more like goals. The target achievements are not specifically identified.

B. Three program strategies are identified, but two are rejected from further consideration. Hence, the PM is devoted principally to implementation of a single strategy.

2.2.2 Lunar Exploration Program (PM dated August 30, 1968)

A. The issue identified is the major issue stated by the Bureau of the Budget at the beginning of the planning cycle.

B. The funding requirements omitted launch vehicles, launch and mission operations and those associated with maintenance of the Saturn-Apollo capability.

2.2.3 Planetary Exploration Program (PM dated September 3, 1968)

A. The issues identified are equivalent to the major issue stated by the Bureau of the Budget at the beginnine of the planning cycle.

2.2.4 Astronomy Program (PM dated August 23, 1968)

A. There are inconsistencies in the handling of ATM missions. In the discussion an ATM-A is inferred for Alternative 2, but the mission is not covered in the resources requirements or launch schedule. In Alternative 2 the Solar ATM mission in 1975 is not funded in the period 1972-75. The funding pattern for ATM-B is not consistent with that shown for ATM-A.

B. The "man-associated" High-Energy ATM and Radio Astronomy projects are shown in the funding tables and launch schedules, but are not included in the project description.

C. Internal issues are not identified.

2.2.5 Space Physics Program (PM dated August 30, 1968)

A. Although a number of international projects are indicated, the goals and objectives nowhere reflect an intent to foster international cooperation.

B. Two strategies are advanced, and on the basis of limited discussion, one is rejected from further consideration. The remaining balanced strategy is developed at three levels of funding.

C. The relationship between resources requirements and the flight program is obscured by the use of sub-programs such as Earth Environment, Interplanetary, and Space Laboratory in the former and specific project titles in the latter.

D. The project description does not include the Meteoroid Satellite.

E. Internal issues are not identified.

2.2.6 Space Biology Program (PM dated September 3, 1968)

A. None identified.

2.2.7 Aircraft Technology Program (PM dated September 3, 1968)

A. The objectives are open-ended and are more like goals. The discussion of objectives, while extensive, does not reveal the specific achievements to be used as targets. In fact, virtually all the research problems identified are cited as examples of work which might be carried out.

B. The use of levels of effort as program strategies is not entirely compatible with the intent of the planning process. In effect, the use of levels of effort represents a single approach.

C. Numerous projects are described, but the projects associated with the program options developed are not identified. Specifically, the funding requirements are stated only in terms of sub-programs such as "General Aviation," "V/STOL Aircraft," etc.

2.2.8 Advanced Space Technology Program (PM dated September 3, 1968)

A. The statements of objectives do not convey the impression of closed-ended specific achievements. The discussion generally reveals the objectives intended, but there is a need for an explicit definition which can be used as the basis for program planning and evaluation. Target dates of achievement are not indicated.

B. There is no planning launch schedule for the flight projects covered by funding in the program options.

C. The AEC-NASA interface in the Nuclear Rocket and Space Power projects is not well illuminated. This relationship should have a significant effect on the development of program options.

D. The use of levels of effort as program strategies is not entirely compatible with the intent of the planning process. In effect, the use of levels of effort represents a single approach.

2.2.9 Space Applications (PM dated August 29, 1968)

A. The objectives in all programs within Space Applications are stated in considerable detail and are generally closed-ended. The associated dates of achievement are not indicated, however, and the impression of sequential accomplishment is not conveyed.

B. Only Strategy I is fully developed. According to the PM, analysis and development of Strategy II has been withheld pending completion of a study at Langley Research Center and Goddard Space Flight Center. Strategy III, based primarily on manned space flight, is discussed briefly and rejected from further consideration.

C. Following are inconsistencies in the resource requirements and planning launch schedule:

(1) The resources requirements for the Synchronous Meteorological Satellite are the same for all funding levels, but the high level has two flights whereas the other two have only one flight.

(2) The Nimbus funding at the low level would indicate a schedule slip for the E and F flights, but this is not reflected in the launch schedule.

D. The issues identified are essentially the same as the major issues identified by the Bureau of the Budget at the beginning of the planning cycle.

2.2.10 <u>Supporting Activities (Tracking and Data Acquisition) Program</u> (PM dated September 11, 1968)

A. Except for the objective on the Data Relay Satellite System, the objectives are open-ended.

B. Program strategies and alternative projects for all the objectives are not developed. The PM notes, however, that Special Analytical Studies #8 and #9 relate to the evaluation of alternatives to the implementation of the Madrid 210-foot antenna and to the impact on overseas operations of various mission models.

C. The resources requirements are not indicated. The Baseline Program data has been assumed to be applicable.

2.3 General Commentary

The following comments are generally applicable to the Program Memoranda:

- The Program Memoranda are too lengthy. The departure from the PSG goal of "20 pages written in telegraphic style" has permitted the introduction of descriptive material which tends to obscure the elements of the rationale and approach.

- The handling of alternative program strategies is not entirely adequate. In some cases several strategies are identified, but with minimum elaboration, one is selected as the basis for the program planning. In other cases the strategies selected are levels of funding. These effects may be partly attributable to the concurrent development of Program Memoranda and synthesis of Agency program alternatives. In such a situation the Program Memoranda would tend to reflect the results of synthesis activity.

- The funding requirements for launch vehicles are not uniformly treated in the Program Memoranda. Most programs provide data which permits their explicit identification, but in a few cases the requirements are merged with those of the associated spacecraft.

Table 2-1.1
EMSF

TA

EXTENSION OF MANNED SPACE FLIGHT

GOALS	OBJECTIVES
To develop, apply, and exploit manned space flight capability for the benefit of the Nation, thereby maintaining a national competence and eminence that will contribute significantly to the Nation's ability to define and control its destiny, preclude preemption of space by others, and support the attainment of other national goals, with special attention to: 1. Operating inthe space environment, utilizing manned space flight technology and flight crew capabilities to a. Pioneer and discover. b. Answer important scientific, technological, and applications questions. c. Support, maintain, and operate space flight systems, experimental apparatus, and other spaceborne equipment. 2. Establishing and maintaining a national capability in manned space flight to enhance military, political, social, and economic security, increasing the capability to gain and maintain a position of world leadership. 3. Studying man, his physiological and psychological responses to the space flight environment and his capabilities in space flight, and applying these to the general study of man's needs and requirements in space and on Earth. 4. Developing technological capabilities required to support man and his activities in space on an expanding scale that will permit the Nation to advance to increasingly productive and challenging missions.	1. Extend the present knowledge of the long term biomedical and behavioral characteristics of man in space culminating by the end of 1975 in the continuous exposure to the space environment of 6 men for 180 days. 2. Continue the development of systems and technology required to maximize the utility of man in space. 3. By the end of [illegible] 4. [illegible]

RESOURCES REQUIREMENTS (M

	BASELINE				
	1970	1971	1972	1973	1974
INT 21 SATURN IB TITAN III M (& FACIL) LAB QCM + LOG. MOM LAB + EXP (MOD. OR MOM) NEW LOG. S/C EXPERIMENTS MISSION OPS DEFINITION ABOVE BASELINE PROGRAM TOTAL	NOTE: EMSF BASELINE PROGRAM IS CONTAINED IN OMSF COMMON, WHICH IS NOT SHOWN.				

PLANNING LAUNCH SC

	1970	1971	1972	1973	1974
LAB MODULES					
CREW LOGISTICS					

TABLE 2-1.1

FLIGHT CAPABILITY (PM DATED SEPTEMBER 3, 1968)

	PROGRAM STRATEGIES	ALTERNATIVE PROJECTS/MISSIONS	ISSUES
end of 1975 develop solutions to the problems of establishing, ng, and resupplying a long duration orbital station. rate the use of manned systems for conducting scientific, ogical, and space applications experiments.	1. Use existing hardware with minimum modification to achieve specific and limited objectives on each flight. 2. Develop new hardware, with characteristics to meet the 1975 objectives, and make significant progress toward the long term aims. 3. Develop new hardware specifically designed to fulfill one of the aims to the exclusion of others.	1. Small Earth Orbital Space Laboratory, which may also serve as element of the resupply vehicle, and Saturn IB launch vehicle. 2. Same as 1, except with Titan III M launch vehicle. 3. Large Earth Orbital Space Laboratory, launches by two-stage Saturn V derivative, and subsequently supported by different logistics spacecraft and launch vehicle.	1. Should Phase C program definition activity for the EOSL and associated experiments be initiated in FY70? If "yes", which of the following to be considered as program requirements: a. Use of Saturn V or Saturn V derivatives? b. With Saturn V launch vehicle, use of Saturn IB/QCSM or Titan IIIM/Gemini vs. new, larger spacecraft as the basis for the logistics vehicle? c. Artificial gravity system? d. Space rescue capability?

TS (MILLIONS OF DOLLARS BY FISCAL YEAR)

		OPTION I					OPTION II					OPTION III				
	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
								13	85	109	49		13	85	109	49
			124	150	103	96							13	67	110	110
									85	83	100					
ROGRAM			2	89	222	203										
OMSF				53	185	270										
S NOT								45	102	159	276		45	102	159	276
								4	164	353	300		4	164	353	300
		10	108	182	184	138	10	91	145	168	136	10	91	145	168	136
					8	94					10				6	76
		28					28					28				
		38	234	474	702	801	38	153	581	872	871	38	166	563	905	947
		38	234	474	702	801	38	153	581	872	871	38	166	563	905	947

CH SCHEDULE (BY CALENDAR YEAR)

					2 3					2					2

Table 2-1.2
Lunar

LUNAR EXPLORATIC

GOALS

To explore the Moon, concurrently extending our space flight technology and operational capability in order to:

1. Advance our understanding of the origin and evolution of the solar system.
2. Resolve the orgin of the Moon and the history of the Earth-Moon system.
3. Increase our understanding of the dynamic processes that shape the Earth and its environment.
4. Increase our understanding of the origin of life.
5. Study man, his physiological and psychological responses to the space environment, his capabilities in space flight, his potential to function on another planet.
6. Develop our space flight technological and operational capabilities on an expanding scale that will permit the Nation to advance to increasingly productive and challenging missions.
7. Determine the potential of the lunar environment for supporting experiments in astronomy, research, and applications.
8. Evaluate the natural resources of the Moon.

OBJECTIVES

1. Accomplish the manned lunar landing mission.

By the mid-1970's:

2. Investigate the form, regional setting and subsurface nature of major lunar surface features and study regional problems by landings at key sites and by extended traverses over the surface.
3. Completely characterize the samples collected at each site and during each traverse by detailed analysis on Earth, including rock identification, chemical composition and age dating.
4. Determine the gross internal structure and processes, ephemeris, and mass distribution by measuring seismic activity, heat flow, and librations with emplaced instrumentation.
5. Survey and measure the lunar surface from orbit about the Moon, tying together studies and traverses into a regional framework, providing detailed information for science planning of surface missions, obtaining lunar-wide control of surface positions and profile and measuring the gravitational field and local variations.
6. Investigate the lunar environment, the interaction of the Moon with the solar wind, associated magnetic fields, atmospheric components resulting from neutralized solar wind, micrometeorite flux, and impact effects, by long-term monitoring on the lunar surface and in orbit.
7. Determine biomedical and behavioral performance including physiological responses and aptitudes, post-mission adaption, and increments by which manned mission duration can be increased. Study man-machine relationships including sensor operation, discrimination, data selection and evaluation, manual control, maintenance and repair, assembly and set-up, and mobility operations on the lunar surface.
8. [illegible]
9. [illegible]
10. [illegible]
11. [illegible]

LUNAR EXPLORATION RESOURCES REQ

	BASELINE					PLAN 13			
	1970	1971	1972	1973	1974	1970	1971	1972	1973
BASELINE	5	5	5	5	5				
SCI. & PROJ. DEF.						10	10	10	30
PHASE C						2			
EXTENDED APOLLO	NOTE: OMSF COMMON NOT SHOWN					92	220	117	75
DUAL MISSIONS									
LUNAR PAYLOAD MODULE									
AUTO. ORBITER									
AUTO. SURF. VEH.									
PARTICLE & FLDS SAT.									
ABOVE BASELINE						104	230	127	114
TOTAL PROGRAM	5	5	5	5	5	109	235	132	119

PLANNING LAUNC

	1970	1971	1972	1973	1974	1970	1971	1972	1973
POST APOLLO						1	1		
EXTENDED APOLLO								1	2
DUAL MISSION									
LUNAR PAYLOAD MOD.									
AUTO. ORBITER									
AUTO. SURF VEH.									
PARTICLE & FLDS. SAT.									

TABLE 2-1.2

ION (PM DATED AUGUST 30, 1968)

	PROGRAM STRATEGIES	ALTERNATIVE PROJECTS/MISSIONS	ISSUES
the ability to conduct manned observations and experiments on the lunar extend investigations beyond the immediate vicinity of the landing site. xploration to regional problems with the capability of supporting rat profiles, atmospheric components, sample collection, and deployment of stations along traverses. surface rendezvous capability. Expand manned landing capability to a ant portion of the lunar surface. ate techniques necessary to make man independent of Earth consumables traction of water, hydrogen and oxygen from lunar rocks) and use of lunar for construction and protection. Study the effect of lunar environment mentation and the suitability of the lunar surface (thermally and ally) for an astronomy observatory and research laboratory.	1. Accomplish several lunar landings and then pause for an undetermined period to assess the results before selecting the following program. 2. Continue lunar exploration with improved Apollo systems and/or new systems.	1. Apollo and Post-Apollo ALSEP 2. Extended Apollo Extended Lunar Module Advanced ALSEP Lunar Flying Unit CSM Subsatellite 3. Advanced Orbiter 4. Automated Surface Vehicle Advanced Surveyor-type Titan III/Centaur or Saturn IB/Centaur 5. Dual Launch Lunar Payload Module Extended Lunar Module Lunar Flying unit Dual Mode Rover 6. Site Revisit Extended Apollo Lunar Payload Module	What lunar exploration program should be undertaken after the first manned landing(s)?

QUIREMENTS (MILLIONS OF DOLLARS BY FISCAL YEAR)

	PLAN 3A					PLAN 3B					PLAN 3C					PLAN 3D				
1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
38	15	15	15	43	43	15	15	15	43	43	15	15	15	43	43	15	15	15	43	43
	8					4	3	2			4					11	1			
63	50	209	146	63	58	92	220	117	70	7						92	220	117	76	63
							44	131	212	160										
																25	161	246	180	26
	6	70	75	27	3						6	70	75	27	3					
	36	165	247	182	108						36	165	247	182	108					
												1	8	11	7					
101	114	459	483	336	212	111	282	265	325	210	60	259	345	263	161	143	396	378	299	133
106	119	464	488	341	217	116	286	270	330	215	65	255	350	267	166	148	401	383	304	138

CH SCHEDULE (BY CALENDAR YEAR)

	2	1				1	1				2	1				1	1			
2			1	1	2			1	2									1	1	2
										1										
			1	3									1	3						
				2	2									2	2					
															2					

Table 2-1.3
Planetary

P

GOALS	
To increase our understanding of: 1. The origin and evolution of the solar system. 2. The origin and evolution of life. 3. The dynamic processes that shape the terrestrial environment.	Mars 1. Conduct exobiological studies that a. Search for and characterize living and fossil organisms. b. Determine presence and characteristics of biogenic or abiogenic organic c. Identify major characteristics of the surface environment particularly distribution and thermal anomalies and variation with geographic posit d. If no life forms, why not? e. Search for minor atmospheric constitutents of possible metabolic origin. 2. Identify major characteristics of the atmosphere: composition, circulation composition of clouds, interaction with polar caps. 3. Define topography, geologic composition, erosion, and weathering mechanisms. 4. Determine internal characteristics: mass distribution, presence of a core, 5. Define solar/galactic flux interactions with the planet. 6. Determine surface features and rotational parameters of Phobos and Deimos. Venus 1. Determine characteristics of the atmosphere: circulation, composition, dist composition of clouds. 2. Define the thermal regime and sources of heat. 3. Define the topography and composition of surface and the atmospheric-surface 4. Define internal mass distribution, gross figure, and shape of planet. 5. Define interaction of solar wind with atmosphere. 6. Determine biological potential of environment and presence of organic molec high surface elevations, and in the polar regions. Mercury 1. Define composition, geologic structure, and temperature variation of surface. 2. Study body characteristics: mass distribution and presence of a core. 3. Define interaction with solar wind; existence of a magnetic field. 4. Determine presence and composition of an atmosphere or ionosphere and susta

RESOURCES

	BASELINE (1970 RUNOUT)					$100M BALANCED OPTION					$100M MARS	
	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	19[illegible]
SR & T, ADV. STUD, EXOBIO, ETC.	20	20	20	20	20	5	5	5	7	7	8	9
DATA ANAL., MARINER REACQUISTION						2	2	2	2	4	2	2
MARS MARINER '69	4					-4					-4	
MARINER-VENUS '67	1					-1					-1	
PIONEER F & G '73	14	14	17	9	3					1		
MARS MARINER '72, '73	53	31	3									
MARS '73 PLAN. EXPL.							5	17	8	3		
MARS '73 MARINER ORB.												13
MARS '73 ORB/RGH LAND.	30	69	111	70	20	-30	-69	-111	-70	-20	-30	-69
MARS '75 PLANET EXPL.									5	17		
MARS '75 ORB/RGH LNDR												
MARS '75 ORB/MIN. SFT. LND.												
MARS '77 ORB/RGH LNDR												
MARS '77 ORB/MIN. SFT. LND.												
MARS '77 ORB/MED. SFT. LND.												
MARS '77 MED. SFT. LNDR												
VENUS '70 PION. E. ORB.						5						
VENUS '72 PLAN. EXPL.						8	9	7	2			
VENUS '73 PLAN. EXPL.							6	21	17	9		3
VENUS '73 F/B + PRBS												
VENUS '75 PLAN. EXPL.									4	13		
VENUS '75 F/B +.PRBS												
VENUS '75 F/B + BVS												
VENUS '75 ORB/RGH LNDR												
VENUS '76 MARINER												
MERCURY '73 MAR. VEN. S/B												
MERCURY '75 MAR. VEN. F/B								6	17	31		
JUP. F/B TO 10 AU, '74												
JUP. '77/78 GND TR.										9		
COMET ENCKE F/B, '74												
COMET D'ARREST F/B, '76												
ASTEROID VESTA F/B, '74												
ASTEROID CERES F/B, '76												
ABOVE BASELINE						-16	-42	-53	-9	73	-25	[illegible]
TOTAL PROGRAM	122	134	151	99	44	106	92	99	90	117	97	[illegible]

PLAN

MARS MARINER. '71		2					2					2
MARS '73 PLAN. EXPL.									1			
MARS '73 MARINER ORB.												
MARS '73 ORB/RGH LNDR.				2								
VENUS '70 PION. E. ORB.						1						
VENUS '72 PLAN. EXPL.								1				
VENUS '73 PLAN. EXPL.									1			
VENUS '73 F/B + PRBS												
MERCURY '73 MAR. VEN. S/B												
PIONEER F & G '72, '73			1	1				1	1			
JUP. F/B TO 10 AU. '74												
COMET ENCKE F/B '74												
ASTEROID VESTA F/B '74												

TABLE 2-1.3

NETARY EXPLORATION (PM SEPT. 3, 1968)

OBJECTIVES

son.

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on and

activity.

and

tion.

tmosphere,

chanisms.

Jupiter

1. Determine the energy balance.
2. Define field and RF radiation sources.
3. Define solar/galactic interactions.
4. Determine nature of the interior and the origin of the magnetic field.
5. Determine the composition and physical state of the atmosphere and its aerosols.
6. Define the dynamical processes of the atmosphere.
7. Study the composition and determine the origin of the red spot.
8. Study the nature of the satellites: atmospheres, surfaces, densities.

Outer Planets

1. Determine composition and structure of the planets and their atmospheres.
2. Study the nature of the satellites.
3. Define magnetic fields, radiation belts, and solar wind/galactic flux interactions.
4. Study the rings of Saturn.

Comets and Asteroids

1. Study composition and physical state of typical comets.
2. Interaction between solar wind and comets.
3. Study cometary dynamics and particle and gas release from the nucleus.
4. Define distribution of matter in the asteroid belt.
5. Study surface features, densities, and rotation periods of typical asteroids.

PROGRAM STRATEGIES

1. Balanced Strategy - Perform systematic exploration of all the planets and solar system bodies with a balanced emphasis among all phases of planetary science including exobiology.
2. Mars Emphasis - Place strong emphasis on Mars exploration, emphasizing exobiological objectives.

ALTERNATIVE PROJECTS/MISSIONS

Mars
(c) 1971 Mariner Orbiter
(c) 1973-75 Explorer Orbiter
1973 Mariner Orbiter
1973-77 Orbiter/Hard Lander
1975-77 Soft Landers

Venus
1970 Pioneer E Orbiter
(c) 1972-75 Explorer Orbiters
1972, 73 75 Mariner Flyby/Atmospheric Probes
1975 Mariner Orbiter/Hard Lander
1976 Mariner Orbiter

Jupiter
1972, 73 Pioneer F & G Flyby
1974 Flyby

Mercury
1973, 75 Mariner Flyby (Via Venus)

Outer Planets (including Jupiter)
1977, 78 Grand Tour

Comets
1974 Encke Flyby
1976 D'Arrest Flyby

Asteroids
1974 Vesta Flyby
1976 Ceres Flyby

(c) common to all options

ISSUES

1. What should be the strategy for the Nation's planetary program?
2. At what rate ($ level) should this program be conducted?

EQUIREMENTS (MILLIONS OF DOLLARS BY FISCAL YEAR)

SIS OPTION		$200M BALANCED OPTION					$200M MARS EMPHASIS OPTION				
1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
10	12	14	17	18	16	10	13	16	17	16	10
2	4	2	2	2	2	4	2	2	2	2	4
		-4					-4				
		-1					-1				
	1					1					1
			5	17	8	3		5	17	8	3
31	8							15	30	25	5
-70	-20										
5	17				5	17				5	17
8	25				3	15					
										25	59
		8	9	7	2		8	9	7	2	
8	4		3	10	8	4		3	10	8	4
4	13									4	13
				17	42	54					
		3	14	29	22	12	3	14	29	22	12
						9					
					10	32					
-2	63	22	50	100	119	161	21	64	113	117	129
87	107	144	184	251	218	205	143	198	264	216	173

$350M BALANCED OPTION					$350M MARS EMPHASIS OPTION				
1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
21	25	27	30	27	22	25	28	32	30
2	3	3	3	5	2	3	3	3	5
-4					-4				
-1					-1				
				1					1
	5	17	8	3					
						13	27	22	5
			5	17				5	17
	3	15	34	56					
						18	52	89	128
			18	42					
								25	41
8	9	7	2		8	9	7	2	
	3	10	8	4		3	10	8	4
20	52	69	34	3	20	52	69	34	3
			4	13				4	13
		5	21	69					
			2	10					
3	14	29	22	12	3	14	29	22	12
		8	12	20			6	11	30
	15	32	56	31					
				8					15
			10	32				10	32
48	129	222	269	352	50	138	231	267	335
170	263	373	368	396	172	272	382	366	379

PHASED OPTION					$500M OPTION				
1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
14	17	18	31	28	28	36	39	40	39
2	2	2	2	4	2	3	3	4	6
-4					-4				
-1					-1				
				1					1
	5	17	8	3		5	17	8	3
						15	30	25	5
			5	17				5	17
						18	52	89	128
			25	41				25	41
8	9	7	2		8	9	7	2	
	3	10	8	4		3	10	8	4
					20	52	69	34	3
			4	13				5	13
		20	52	69					
						6	30	69	111
			2	10				2	10
3	14	29	22	12	3	14	29	22	12
		8	12	20			8	12	20
						15	32	56	31
				9					9
						12	39	77	28
			10	32			6	21	49
						22	50	62	21
								12	27
22	50	112	184	263	56	210	421	577	578
144	184	263	283	307	178	344	572	676	622

NING LAUNCH SCHEDULE (BY CALENDAR YEAR)

			2					2			
					1					1	
1										1	
					2					2	
				1					1		
1					1					1	
					1					1	
1				1	1				1	1	

	2					2			
			1						
								1	
			2					2	
		1					1		
			1					1	
			2					2	
			1					1	
		1	1				1	1	
				1					

	2					2			
			1					1	
								1	
			2					2	
		1					1		
			1					1	
								2	
			1					1	
		1	1				1	1	
									1
									1
									1

Table 2-1.4
Astronomy

ASTRC

GOALS

To understand the origin, evolution, present structure, and physical processes taking place in the solar system, stellar system, and the universe by complementing Earth-based observations with observations from space.

OB.J

1969

1. Map the sky in the ultraviolet and determine stellar energy distributions and emission line intensities of diffuse nebulae.
2. Make moderate resolution (2Å) ultraviolet spectrophotometric measurements (1000-3500 Å of major classes of stars and the planets.
3. Map the galaxy with low-resolution at frequencies between 0.05 and 10 MHz. Monitor burst radiation from Jupiter and the Sun.

1970

1. Map the sky in the X-ray wavelength between 0.1Å and 10Å. Monitor the brightness changes in the brighter sources.
2. Obtain high-resolution ultraviolet spectra of hot stars and the brighter planets.

1971

1. Make observations of transient activity near solar maximum with a spatial resolution of 5 arc seconds.
2. Obtain preliminary data on man's capability to operate sophisticated astronomical instruments in space.
3. Make gamma ray maps of the sky (energies above 50 MeV): determine the size and shape of the galactic center source.
4. Obtain high dispersion spectra (1000-3500 Å) of Venus; Mars, Jupiter, and Saturn.

1972

1. Map the sky in the X-ray frequencies (0.01-40 Å) with a position accuracy of 5-10 arc seconds for the brighter sources: map the Virgo cluster of galaxies for evidence of extra-galactic X-rays.
2. Perform synoptic observations of the solar corona between 1.5-6 solar radii.
3. Make a sky survey in the X-ray (0.1-200 Å) and ultraviolet (1000-3000 Å) wavelengths.
4. Obtain moderate resolution UV spectra of a variety of stars.

RESOURCES REQUI

	1970	197
SOUNDING ROCKETS	10	[illegible]
EXPLORERS	7	[illegible]
OSO	10	[illegible]
OAO	27	[illegible]
OWSE		
HI-ENERGY ATM (B)		
AIRPLANE OBS.		
SR&T, DATA ANALYSIS & ADV. STUDIES	10	[illegible]
LAUNCH VEHICLES	11	[illegible]
STELLAR ATM		
STELLAR ASTRA		
RADIO ASTRONOMY		
ABOVE BASELINE		
PROGRAM TOTAL	75	[illegible]

PLANNING

SOUNDING ROCKETS		
EXPLORERS	1	[illegible]
OSO	1	
OAO	1	
AIRPLANE OBSERVATORY		

* NOTE: ATM & OWSE FLIGHTS SHOWN AS PART OF EMSF SCHEDULE

TABLE 2-1.4

NOMY (PM DATED AUGUST 23, 1968)

ES	PROGRAM STRATEGIES	ALTERNATIVE PROJECTS/MISSIONS	ISSUES
1972-1975 1. Make an infrared sky survey to obtain low-dispersion (several hundred Ångstroms) spectrophotometric data of the planets and infrared objects in the wavelengths between 2μ and 1 mm. 2. Make a sky map in the hard X-ray/soft gamma ray regime (energies of 1 KeV to 1 MeV). 3. Obtain moderate resolution (10's of Ångstroms) spectra of hot stars and other objects in the UV. 4. Obtain high resolution (0.1Å) UV spectrophotometric data for bright stars and planets and moderate resolution (10's of Ångstroms) data for faint objects of special interest. 5. Obtain solar minimum and quiescent solar data on the UV and X-ray spectra from selected small solar regions, X-ray polarization effects, and the morphology of solar flares, sunspots, and coronal streamers. 6. Determine the size and structure of Sco X-1, the Crab Nebula, and selected bright X-ray objects to assist in determining the physical processes causing this radiation; search for and study line radiation in supernova remnants. 7. Make detailed observations of the sun in the 1500-10000 Å range as the new solar cycle begins. 8. Make observations from the near-infrared to millimeter wavelengths of planetary atmospheres, proto-stars, quasars, the sun, and selected comets utilizing an aircraft-mounted 36" telescope at altitudes in excess of 40,000 feet. 9. Operate an orbiting one-meter aperture diffraction-limited telescope. 10. Conduct manned astronomical observations.	1. Continue present automated missions, conduct ATM-A mission. 2. Continue present automated missions with improvements; conduct ATM-A mission; conduct follow-on ATM missions. 3. Continue present automated missions with improvements; conduct ATM-A mission; conduct a vigorous, diversified manned observatory program beginning in 1975.	Airplane Observatory Sounding Rockets Explorers (e.g., RAE, SAS) OSO Helios OAO EOSL experiments ASTRA Solar ATM Stellar ATM High Energy ATM Manned Radio Astronomy MASO	NONE IDENTIFIED

REMENTS (MILLIONS OF DOLLARS BY FISCAL YEAR)

BASELINE			ALTERNATIVE 1					ALTERNATIVE 2					ALTERNATIVE 3				
1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
10	10	10				1	3				1	3				1	2
2			3	10	20	28	32	3	10	20	28	32	3	10	28	28	32
2			5	12	15	16	12	5	12	15	16	12	5	12	15	16	12
2	1		15	23	24	24	14	15	23	24	24	14	15	23	24	24	14
				8	8	9	9		8	8	9	9		8	8	9	9
				2	10	15	20		2	10	15	20		2	10	15	20
			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
10	10	10	2	5	8	11	14	2	5	8	11	14	2	5	8	11	14
				8	8	12	9		8	8	12	9		9	8	12	8
											5	20					
														10	17	25	35
																	2
			27	73	96	120	116	27	73	96	125	136	27	83	120	145	152
25	21	19	102	111	121	141	135	102	111	121	146	155	102	121	145	166	171

LAUNCH SCHEDULE*(BY CALENDAR YEAR)

			30	33	36	39	41	30	33	36	39	41	32	33	36	39	41
			1	1	2	3	4	1	1	2	3	4	1	1	2	3	4
			1		1		1	1		1		1	1		1		1
			1		1			1		1			1		1		

INITIAL FLIGHT PLANNED FOR 1970-71 TIME PERIOD

T

SPACE PHYSICS (PM

GOALS	OBJECTIVES
1. To explore new regions of space to increase our understanding of the nature and evolution of the solar system and the universe. 2. To define the space environment and assess the hazards to space systems and men. 3. To obtain a detailed understanding of the physical interactions and dynamic processes which control the Earth's space environment. 4. To exploit space as a laboratory for experiments not feasible on Earth.	1. Explore interplanetary space in to 0.3 AU from the Sun and out to the orbit of Jupiter. 2. Extend available data on the space environment near Earth and initiate data acquisition between 0.3 and 5 AU from the Sun. 3. Investigate specific phenomena to obtain a detailed understanding of the physical interactions and dynamic processes that control Earth's space environment. a. Thermospheric aeronomy. b. Ionospheric photochemistry and dynamics. c. Formation and decay of radiation belt particles. d. Magnetospheric convection, plasmapause. e. Solar wind interactions with Earth's environment. f. Aurorae and airglow. g. Cosmic dust influx. 4. Perform selecte[illegible] a. Tests of [illegible] b. Spacecraft [illegible] c. Gravity-free [illegible] d. High energy [illegible] e. Study of [illegible]

RESOURCES REQUIREMENTS (

	BASELINE REGROUPED ACCORDING TO PM CATEGORIES				
	1970	1971	1972	1973	1974
ART/SRT/SOUND ROCKETS	24	24	24	24	[illegible]
EARTH ENVIRON.	22	12	6	2	[illegible]
INTERPLANETARY	7	6	2	1	
SPACE LAB					
L/V	9	4	3		
ABOVE BASELINE					
TOTAL PROGRAM	62	46	36	27	[illegible]
NOTE: The baseline has been regrouped according to PM categories. Sounding rockets, ART & SRT have been combined to compare with the PM Category "Program Support".					

PLANNING LAU

	1970	1971	1972	1973	1974
OGO					
IMP	1	1	1		
ATMOS. EXPL.					
CLUSTER					
ISIS	1	1			
SSS	1	1			
METEOROID					
COOPERATIVES	3				
PIONEER					
SUNBLAZER	1	2	2		
SOLAR PROBE					
ASTEROID PROBE					
PLANETARY CRUISE					
SPACE LAB					

TABLE 2-1.5
S (PM DATED AUGUST 30, 1968)

	PROGRAM STRATEGIES	ALTERNATIVE PROJECTS/MISSIONS	ISSUES
'orm selected investigations using space as a laboratory. Tests of general relativity. Spacecraft external environment observations. Gravity-free behavior of liquids, solids, and gases. High energy physics experiments Study of large scale plasmas.	1. Conduct a balanced program with some effort directed toward all goals in the next few years. 2. Concentrate effort toward some of the goals while dropping all effort toward at least one goal.	IMP (K-L) AE (C-D) ISIS SSS ASTEROID PROBE METEOROID SATELLITE PHYSICS LAB. EXPERIMENTS UNIVERSITY SATELLITES SOLAR PROBE SUNBLAZER PIONEERS (H,I...) RELATIVITY SATELLITE EOSL EXPERIMENTS COOPERATIVE SATELLITES CLUSTER SATELLITE PLANETARY CRUISE MODE EXPERIMENTS	NONE IDENTIFIED.

NTS (MILLIONS OF DOLLARS BY FISCAL YEAR)

ACCORDING IES		PROGRAM ALTERNATIVE 1					PROGRAM ALTERNATIVE 2					PROGRAM ALTERNATIVE 3				
.973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
24	24	6	11	11	11	16	3	3	3	3	3	2	2	0	-4	-6
2	1	13	26	51	58	58	10	19	27	31	36	7	13	15	18	19
1		2	8	22	22	32	1	3	5	10	10	1	3	3	4	5
		5	15	20	31	30	3	7	13	12	11			3	5	9
		3	3	20	36	36	3	3	19	21	20	3	3	11	12	12
		28	62	123	156	171	19	35	66	77	79	12	21	31	35	38
27	25	90	108	159	183	196	81	81	102	104	104	74	67	67	62	63

LAUNCH SCHEDULE (BY CALENDAR YEAR)

		1	1	1	1	1	1	1	1	1	1	1	1	1		1
				1	1	1			1	1				1	1	
					1						1					
		1	1				1	1				1	1			
		1	1	1	1	2	1	1	1	1	1	1	1	1		1
					1						1					
							3					3				
						1										
		1	2	2			1	2	2			1	2	2		1
					1	1				1	1				1	1
						1										
				1	1					1	1			1	1	
					1	1				1	1					

Table 2-1.6
Biology

SPACE B[illegible]

GOALS	
To gain new fundamental biological knowledge by using space flight as a research tool.	1. Survey the biological effects of weightlessness in Earth orbit on the physiology, morphology, and behavior of various organisms. 2. Survey the effect on biorhythms of removal from Earth periodicities. 3. Survey the biological effects of weightlessness combined with controlled radiation in Earth orbit.

RESOURCES REQU[illegible]

	BASELINE					PLAN 1				
	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
SR&T	7	7	7	7	7					
BIOSATELLITE (A-F)	39	32	17	8				[illegible]	2	
FOLLOW-ON BIOSAT.						1	4	[illegible]	22	[illegible]
BIOPIONEER						1	3	[illegible]	9	[illegible]
IMPROVED BIOSAT.										
BIOEXPLORER										
ADVANCED BIOSAT.										
BIO-A (PRIMATES)						[illegible]	10	[illegible]	51	[illegible]
BIO-C (MICROBIO.)										
BIO-D (SMALL ANIMALS)							1	[illegible]	9	[illegible]
BIO-E (PLANTS)							2	[illegible]	10	[illegible]
BIO-F (INVERTEBRATES)										
EXP. DEF.						[illegible]	1	1	1	
EXP. INT. & S/C. MOD.										
ABOVE BASELINE, BASIC						2	8	[illegible]	34	[illegible]
ABOVE BASELINE, SUPPLEMENT						4	14	[illegible]	70	[illegible]
TOTAL BASIC PRGRM.	40	39	24	15	7	42	47	[illegible]	[illegible]	[illegible]
TOTAL PRGRM. WITH SUPPL.						47	61	[illegible]	[illegible]	[illegible]

OPTIONAL SUPPLEMENT

PLANNING

	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
BIOSATELLITE (C-F)	1	1	1							
FOLLOW-ON BIOSAT.									1	
BIOPIONEER									1	
IMPROVED BIOSAT.										
BIO EXPLORER										
ADVANCED BIOSAT.										
BIO-E (PLANTS)										
BIO-F (INVERTEBRATES)										

TABLE 2-1.6
E BIOLOGY (PM DATED SEPT 3, 1968)

IVES

4. Survey the biological effects of high energy, heavy particle, and cosmic radiation on selected biological organisms.

5. Study the mechanisms of response and adaption of organisms to weightlessness, space radiation, and removal from Earth periodicities.

PROGRAM STRATEGIES

1. Make a b oad survey of biological effects of the space environment on a wide variety of species to discover the most important and promising areas for more intensive future investigations.
2. Deemphasize broad survey, and concentrate on intensive investigations of a few organisms and biological systems selected a priori by the best scientific judgment.
3. Simultaneously carry out limited survey studies and selected intensive investigations of biological systems.
4. Concentrate on species and biological systems selected to provide fundamental data related to manned space flight.

ALTERNATIVE PROJECTS/MISSIONS

1. Follow-on Biosatellite.
2. Improved Biosatellite.
3. Advanced Biosatellite.
4. Biopioneer.
5. Bioexplorer.
6. Biotechnology Laboratory.

ISSUES

1.
   a. What manned space flight opportunities and capabilities will be available to space biology experiments?
   b. What rationale should guide the selection of experiments for the manned program?
2. What new starts will be implemented in FY70?

EQUIREMENTS (MILLIONS OF DOLLARS BY FISCAL YEAR)

	PLAN B					PLAN C					PLAN D					PLAN E					PLAN β				
1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
	1	2	3	4	5	1	2	3	4	5	3	4	5	6	6	1	1	2	2	3	1	1	2	2	3
1			4	2	1			4	2	1			4	2	1			4	2	1			4	2	1
18						1	4	15	16	8															
7	1	3	6	9	7	1	3	6	9	7	1	3	6	9	7	1	1	3	6	9	1	3	6	9	7
	1	6	13	21	25	1	1	6	13	21						1	6	13	21	25					
						1	4	6	6		1	4	6	6	6	1	8	12	12	12					
											1	11	14	36	44										
97	OPTIONAL SUPPLEMENT 1	10	20	51	97	OPTIONAL SUPPLEMENT 1	10	20	51	97	OPTIONAL SUPPLEMENT					OPTIONAL SUPPLEMENT 1	10	20	51	97	1	10	20	51	71
																					1	1	2	3	3
10	1	1	2	9	10	1	1	2	9	10	1	1	2	9	10	1	1	2	9	10	1	1	2	3	3
3	1	2	8	10	3	1	2	8	10	3	1	2	8	10	3	1	2	8	10	3	1	2	3	3	2
																					1	2	3	3	2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
																							10	24	42
26	4	11	26	36	38	5	14	41	51	42	6	22	35	59	64	4	16	34	43	50	9	22	54	102	136
111	4	14	31	70	111	4	14	31	70	111	3	4	11	19	14	4	14	31	70	111					
33	44	50	50	51	45	45	54	65	65	49	46	61	60	74	71	44	56	58	59	57	48	61	78	118	143
144	48	64	81	121	156	49	68	96	135	160	49	65	71	93	85	48	70	89	129	168					

IING LAUNCH SCHEDULE (BY CALENDAR YEAR)

	B 1970	B 1971	B 1972	B 1973	B 1974	C 1970	C 1971	C 1972	C 1973	C 1974	D 1970	D 1971	D 1972	D 1973	D 1974	E 1970	E 1971	E 1972	E 1973	E 1974	β 1970	β 1971	β 1972	β 1973	β 1974
1									1	1															
1				1	1				1	1				1	1					1				1	1
					1															1					
								1	1				1	1	1			2	2	2					
															1										
					1					1					1					1					1
																									1

Table 2-1.7
Aircraft Technology

AIRCRAFT TECH

GOALS	OBJECTIVES
1. To expand fundamental knowledge important to advances in atmospheric flight through analysis and experiment. 2. To demonstrate, to the degree necessary to establish confidence, the translation of fundamental knowledge into practical solutions for military and civil air transport problems.	<u>Advanced Research</u>* 1. Apply modern analytical and experimental techniques to achieve increased quantitative analysis of older aeronautical sciences (aerodynamics, propulsion, loads and structures, materials). 2. Develop research programs in the newer sciences (avionics, human factors, flight dynamics, operational environment) of importance to the advancement of aeronautics. Support 1. Gene 2. V/S by 3. Subs pre 4. Supe of 5. Hype pra *The PM lists numerous specific examples of investigations to be undertake

RESOURCES REQUIREMEN

	BASELINE		
	1970	1971	1972
ART/SRT	40	40	40
GENERAL AVIATION	2	2	2
V/STOL AIRCRAFT	8	8	8
SUBSONIC AIRCRAFT	25	21	3
SUPERSONIC AIRCRAFT	16	16	16
HYPERSONIC AIRCRAFT	7	6	6
AIR TRAFFIC CONTROL			
ABOVE BASELINE			
TOTAL PROGRAM	98	94	76

TABLE 2-1.7
HNOLOGY (PM DATED SEPT 3, 1968)

	PROGRAM STRATEGIES	ALTERNATIVE PROJECTS/MISSIONS	ISSUES
ıg Technology* al Aviation - Conduct research on those basic sciences of particular tance to this class of aircraft emphasizing those features leading to um safety through ease of operation by relatively untrained personnel. L Aircraft - Resolve those problems which have prevented exploitation vil and military aviation of the full potential of V/STOL aircraft. nic Jet Aircraft - Continue research enabling solution to problems nting full exploitation of this major transportation mode. sonic Aircraft - Conduct research enabling realization of national goals fe, efficient, supersonic cruise flight for military and civil aircraft. sonic Aircraft - Continue research directed toward determining the icality of sustained flight at hypersonic speeds (Mach 6-12). : in support of the more general objectives.	Level of effort at three funding levels corresponding to: 1. Projection of FY69, but not incorporating NASA-initiated proof-of-concept. 2. Full support of advanced research with high-value proof-of-concept as now identifiable. 3. Same as 2 plus major attack on Air Traffic Control problem.	Numerous projects are described in the PM, but the projects associated with the program options are not explicitly identified.	1. Should the government accelerate continued advances in air transport and strongly guide the direction of these advances for national benefits? 2. To what extent should the government initiate and conduct proof-of-concept? 3. Should NASA initiate an Air Traffic Control program?

NTS (MILLIONS OF DOLLARS BY FISCAL YEAR)

		PLAN 1					PLAN 2					PLAN 3				
73	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
40	40	-6	-2	3	3	3	-6	6	19	29	29	-6	6	19	29	29
2	2				1	1			2	4	4			2	4	4
8	8	10	12	14	17	22	14	25	33	33	35	14	25	33	33	35
1	1	11	14	27	24	24	11	21	31	26	25	11	21	31	26	25
16	16	10	24	29	29	29	10	30	58	56	57	10	30	58	56	57
4	4	2	-1	4	21	31	2	-1	4	21	31	2	-1	4	21	31
												10	44	60	80	80
		27	46	76	96	111	31	80	147	171	182	41	134	207	251	262
70	70	125	140	152	166	181	129	174	223	241	252	139	218	283	321	332

TA

ADVANCED SPACE TECHNOL

GOALS	OBJECTIVES
1. To provide a technological base for advanced systems and missions, thus providing increased flexibility in accomplishing such missions and improving the economy and effectiveness of space systems and operations. 2. To assist in solving development and operating problems and improving the performance and economy of existing systems. 3. To advance national engineering capability and promote the application of space technology to other activities.	1. Conduct research on the problems of space flight to increase our capability to explore and utilize space. a. Determination of natural and induced environments resulting from flight through the atmosphere, in space, and upon reentry. Determination of structural ability to withstand these loads and provide protection against these environments. b. Research on chemical and nuclear propulsion systems to increase performance, reliability, and life and reduce weight, volume, and cost. c. Research on chemical, solar, and nuclear space power systems to increase performance, reliability, life, and operating versatility and to decrease weight, volume, and cost. d. Research on human performance to assure man's ability to live and perform effectively in space. e. Research on life support, protection from the environment of space, and machine assistance systems for missions of increasing complexity and duration. f. Research to improve electronics systems. g. Research in the physical sciences basic to space flight with emphasis on materials sciences, fluid physics, electrophysics and applied mathematics. 2. [illegible] 3. [illegible] 4. [illegible]

RESOURCES REQUIREMENTS (M

	BASELINE				
	1970	1971	1972	1973	1974
SPACE VEHICLES					
ART/SRT	27	27	27	27	27
SMALL FLT. PROJ.	2	2	2	2	2
SCOUT REENTRY	1				
LIFTING BODY	1	1	1	1	1
INTER. METEOR. PROBE					
RADIO TELESCOPE TECH.					
CHEMICAL PROPULSION					
ART/SRT	27	27	27	27	27
LOW COST 1ST STG.					
CHEM. RKT. EXP. ENG.					
HIGH PERF. S/C PROP.					
NUCLEAR ROCKETS					
SRT	10	10	10	10	10
NRDS					
NERVA TECH.	5				
NERVA DEV.					
SPACE POWER & ELEC. PROP.					
ART/SRT	33	33	33	33	33
SNAP-8					
SERT	2				
ADV. SOLAR ELEC. FLT.					
HUMAN FACTORS					
ART/SRT	15	15	15	15	15
SMALL FLT. PROJ.	2	2	2	2	2
ELECTRONIC SYSTEMS					
ART/SRT	20	20	20	20	20
RAM					
EARTH COV. HORIZ. MEAS.					
OPTICAL TECH. TELESCOPE					
BASIC RESEARCH					
ART/SRT	14	14	14	14	14
LAUNCH VEHICLE					
ABOVE BASELINE					
TOTAL PROGRAM	158	150	150	150	150

TABLE 2-1.8
NOLOGY (PM DATED SEPTEMBER 3, 1968)

	PROGRAM STRATEGIES	ALTERNATIVE PROJECTS/MISSIONS	ISSUES
echnology for an economical transportation system for round trips to Earth pacecraft technology for Earth orbital, lunar, and planetary missions. nuclear rocket engine suitable for flight.	General strategy includes: Selection of technology elements with greatest potential for new capabilities, multiple applications, and cost savings in development and operations. Emphasizing technology elements critical for the success of most important classes of missions. Maintaining competence of the research centers. Specific strategies are expressed as levels of effort: 1. Adopt Benchmark level ($204 million in FY70) 2. Optimize for rapid recovery from FY69 level 3. Hold FY70 at FY69 level.	1. Space Vehicles Small Flight Projects Scout Reentry Lifting Body Interplanetary Meteoroid Probe Radio Telescope Technology 2. Chemical Propulsion Large Solid Motor Chemical Rocket Experimental Engine Low Cost 1st Stage Proof of Concept High Performance S/C Propulsion 3. Nuclear Rockets NRDS NERVA Technology NERVA Development 4. Space Power and Electric Propulsion SNAP-8 SERT Advanced Solar Electric Flight 5. Human Factors Systems Small Flight Projects 6. Electronics Systems RAM Earth Coverage Horizon Measurements Optical Technology Telescope 7. Basic Research	1. At what funding level should ART/SRT proceed? 2. Should development of a flight type nuclear rocket engine be initiated? 3. Should development of the SNAP 8 be continued? 4. Should proof-of concept tests of the low cost booster be initiated? 5. Should the interplanetary meteoroid probe program definition phase be initiated?

S (MILLIONS OF DOLLARS BY FISCAL YEAR)

	LEVEL I					LEVEL II					LEVEL III				
1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
27 2	3	3	4	5	4	3	4	5	6	5	-1	3	4	4	5
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2 1	4 2	4 4	2 5	2	4 1	4 2	2 4	1 5		2 1	4 2	4 4	2 5
27	18	15 12	8 12	9 12	9 2	22 4	17 12	18 12	18 12	22 2		18 12	17 12	15 12	22 2
			6	10	11		6	10	11	11			6	10	11
10															
	21	3	5	5	5	21	3	5	5	5	12	2	5	5	5
		38	37	34	30		38	37	34	30		35	40	36	33
33	7 5	13 6	14 7	13 4	14	11 8	20 6	24 7	23 4	21	1 5	6 6	14 7	13 4	13
		3	6	10	5		3	6	10	5		3	6	10	5
15 2	7 1	17 1	28 1	30 1	31 1	15 1	28 1	37 2	41 2	41 2		7 1	17 1	27 1	30 1
20	13	20	26	45	40	20	27	33	52	52	1	12	20	26	44
		[illegible]	5 7	7 12	7 10		3 6	5 7	7 12	7 10			3 6	5 7	7 12
14	3 2	[illegible] 4	5 2	5 9	6 8	3 2	5 4	5 4	6 8	7 7	2	3 4	4 2	5 7	5 9
150	77 235	154 304	181 331	220 370	191 341	112 270	190 340	225 375	258 408	234 384	18 176	118 268	170 320	196 346	212 362

Table 2-1.9
Applications

TAB

SPACE APPLICATIONS (P

GOALS	OBJECTIVES	
To develop the space technology and sensory techniques to meet the needs and desires of a society increasing in density, mobility, and complexity, with special attention to such areas as: 1. Protection from and exploitation of the elements. 2. Knowledge of and efficient use of Earth resources. 3. Accurate Earth reference system. 4. World-wide and national communications. 5. Safe, economical, and swift, transportation.	Meteorology 1. Develop technology to improve long range and short-term weather forecasting. 2. Support data gathering experiments such as Global Atmospheric Research Program (GARP). 3. Provide meteorological data for advanced aircraft and spacecraft design. Earth Resources Survey 1. Develop and demonstrate remote sensor technology applicable for Earth resources survey from aircraft and spacecraft. 2. Determine the utility of satellite and aircraft systems. 3. Develop data processing and dissemination techniques. 4. Determine the economic benefits expected through attainment of disciplinary objectives in agriculture oceanography, geography and cartography, geology and hydrology. Communications 1. Develop the technology to demonstrate small-terminal, multiple-access systems. 2. Develop and demonstrate the technology related to TV broadcasting and distribution. 3. Develop improved frequency utilization techniques. 4. Develop and demonstrate a space data relay capability.	Navigation and Traffic C[illegible] 1. Achieve the object[illegible] Committee for aircraf[illegible] a. Position accura[illegible] b. Transfer of [illegible] frequencies of [illegible] c. Design of low[illegible] d. Pos[illegible] 2. Provide [illegible] a. A[illegible] b. A[illegible] frequency of [illegible] 1-hour intervals [illegible] supporting Earth[illegible] Geodesy 1. Achieve the objective[illegible] a. Earth reference [illegible] 3-dimensional [illegible] b. Refined definit[illegible] spherical harmon[illegible] 2. Demonstrate the uti[illegible] an accuracy of ± 5 m[illegible] 3. Measure the relativ[illegible] observation stations [illegible] 4. Obtain better measure[illegible] rotation rate. 5. Begin establishment [illegible] and slopes.

RESOURCES REQUIREMENTS (MI

	BASELINE					
	1970	1971	1972	1973	1974	1970
TIROS M/TOS IMPR.	4	3	2	2	2	
NIMBUS A-F	43	28	20	10	3	
METEO. SNDNG. ROCKETS	3	3	3	3	3	
ATS (A-G)	44	49	43	23	13	-5
GEOS	2					
INT'L APPL. SAT (IAS)	1					
SRT/ADV. STUDIES	20	20	20	20	20	4
ERS - A/C	7	6	7	6	7	6
ERTS						9
SRT/AAFE						36
TIROS EXPERIMENTS						2
SYNCH. MET. SAT.						9
W.W.W.						2
TIROS FOLLOW ON						1
NIMBUS G & H						
MET ATS						
LO ALT. EQU. SAT						
ERS LOM						6
I.S.E. (ERTS)						15
ATS H & J						5
DRSS						2
COMMUNITY T.V.						
DIRECT T.V.						
ATS (K-M)						
NAV. TRAF.						6
GEOS-C						4
GEOS-D						1
AAP/EMSF						(16
ABOVE BASELINE						106
TOTAL PROGRAM	124	109	95	68	48	[illegible]

PLANNING LAUNCH SC

NIMBUS (C-F)						
MET ATS						
METEO. SNDNG. ROCKETS						
SYNCH. MET. SAT.						
TIROS FOLLOW ON						
W.W.W.						
LO ALT. EQU. SAT.						
ERTS						
ERS LOM						
I.S.E. (ERTS)						
ATS (E-M)						
DRSS						
COMMUNITY T.V.						
NAV TRAF						
GEOS (C,D)						

TABLE 2-1.9
ONS (PM DATED AUGUST 29, 1968)

	PROGRAM STRATEGIES	ALTERNATIVE PROJECTS/MISSIONS	ISSUES
nd Traffic Control the objectives developed by the six-agency Joint Navigation Satellite ee for aircraft navigation, traffic control aids and related communications: ition accuracy of 2 nm for aircraft. nsfer of digital data and voice between aircraft and ground via satellite at quencies of UHF and higher. ign of low-cost user collision avoidance equipment. ition accuracy of 1/2 nm for specialized aircraft. ship positioning capabilities: uracy of 1 nm for position determination by shore-based stations. uracy of 1 nm for commercial ships on world-wide basis: of 1 nm at a quency of once every 10 minutes for search and rescue craft; of 2 nm at our intervals for ice-breaking vessels; as required for oceanographic ships porting Earth Resources Survey Program. the objectives of the National Geodetic Satellite Program: th reference system based on location of widely separated control points with imensional accuracy of ± 10 meters. ined definition of Earth's gravitational field, establishing coefficients for erical harmonic development through 15th order and degree. rate the ut[illegible] satellite altimeters for mapping the ocean surface with racy of ± 5[illegible] the relative locations of NASA tracking stations and some geophysical tion stations with an accuracy of ± 1 meter. better measurements of Earth tides, polar motion, Chandler wobble, and n rate. stablishment of network of marine control points on the continental shelves nes.	1. Place strong emphasis on utilizing essentially existing spacecraft systems for development of sensor and technique technology. 2. Conduct sensor and technique development and demonstration using new generation spacecraft systems. 3. Use manned spacecraft as the primary means.	Meteorology 1. Nimbus 2. Tiros 3. Synchronous Meteorological Satellites 4. World Weather Watch 5. Meteorological ATS 6. Low Altitude Equatorial Satellite Earth Resources Survey 1. ERS Aircraft 2. ERTS Communications 1. Applications Technology Satellites 2. Data Relay Satellite System 3. Community TV 4. Direct TV Navigation and Traffic Control 1. Navigation and Traffic Control Satellite System Geodesy 1. GEOS	1. What combination of projects best meets the Space Applications Program's objectives? 2. Which new starts should be supported in FY 1970? Special attention is required for the following proposed new starts: a. Earth Resources Technology Satellite (ERTS). b. Nimbus and ATS Follow-On. c. Synchronous Meteorological Satellite (and Integrated Systems Experiment). d. Tracking and Data Relay Satellite System (TDRSS) (an Integrated Systems Experiment) 3. Which alternate criteria for initiating flight projects should be used in place of economic benefits? 4. What should be the role of NASA in the Global Atmospheric Research Project program? 5. What will be NASA's future role in Space Applications R&D and prior to the implementation of operational system by the user agencies? The 1968 National 6. To what extent should NASA reevaluate the funding of back-up spacecraft to insure continuity of the program?

NTS (MILLIONS OF DOLLARS BY FISCAL YEAR)

	NO. 1					NO. 2					NO. 3				
1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
2															
3					3					3		-4	-4	+4	+5
3															
13	-5	-10	-10	-10	-10	-5	-10	-10	-10	-10	-5	-10	-10	-10	-10
20	4	9	9	9	9	4	9	9	9	9	4	9	9	9	9
7	6	6	6	6	6	4	4	4	4	4	3	3	3	3	3
	9	22	26	23	34	10	13	9	9		2	13	13	9	6
	36	35	36	9	9	21	20	18	7-	7	9	2	6		
	2	2	2												
	9	8	1			9	8	1				9	8	1	
	2	11	46	47	15	2	8	36	29	8		5	20	14	2
	1	4	11	9	2		-5	11	9	2					
		1	4	25	35			1	4	25					
		2	4	11	13			10	7	5					
			5	24	30			1	4	24			1	4	19
	6	6	9	5	1	6	4	3	3	4	6	4	3	3	4
		2	11	11	6			2	11	11					
	15	26	43	39	17	10	20	26	33	29		10	20	26	32
	5	14	29	53	49	5	12	28	50	46		12	28	50	46
	2	10	16	40	30		3	10	26	40					
		5	20	31	47										
			5	15	31										
	6	21	20	7	2			3	19	20					
	4	4	2	2	2	4	4	2	2	2	4	4	2	2	2
	1	5	3	2	1	1	5	3	2	1					
	(16)	(16)	(12)	(8)	(11)	(12)	(11)	(8)	(6)	(6)	(1)	(3)	(3)	(5)	(4)
	106	183	300	354	330	73	106	170	216	232	23	69	105	117	122
48	230	[illegible]	395	422	378	197	215	265	284	280	147	172	200	185	170

CH SC[illegible]DULE (BY CALENDAR YEAR)

	1		1	1	1	1		1	1		1		1	1	
					2				1						
			210/YR					200/YR					160/YR		
			1		1		1						1		
				1					1						
				2	1				2					1	
					1										
		1	1		1		1		1				1		1
	1	1	1	1	1		1	1	1	1		1	1	1	1
				1						1					
			1	1	1			1	1	1			1	1	
					1					1					1
					1										
			1	1						1					
	1		1			1		1			1				

Table 2-1.10
Supporting Activities (T&DA)

SUPPORTING ACTIVITIES (TRACKING A

GOALS	OBJECTIVES
1. To provide adequate facilities and services to insure that tracking and data objectives of flight programs are achieved.	1. Increase operating efficiency, particularly at overseas stations. 2. Increase data acquisition capability for support of the planetary program.

RESOURCES REQUIREMENT

TRACKING &

TABLE 2-1.10

ING AND DATA ACQUISITION, PM DATED SEPTEMBER 11, 1968)

3	PROGRAM STRATEGIES	ALTERNATIVE PROJECTS/MISSIONS	ISSUES
3 Provide full time communications capability in the form of a Data Relay Satellite System to support Earth orbital missions.	(Strategy is dependent on selected NASA mission model.)	1. Interim Data Relay Satellite System. 2. Tracking and Data Relay Satellite System.	1. Shou'd FY70 funds be approved for a Phase B study of a Data Relay Satellite System?

MENTS (MILLIONS OF DOLLARS BY FISCAL YEAR)

	BASELINE				
	1970	1971	1972	1973	1974
RACKING & DATA ACQUISITION	298	306	319	326	326

Table 2-2
Major Issues

Major Program Issues for

Extension of Manned Space Flight Capability Program

1. What are the goals, objectives, technical approach, and rate of activity, of earth orbital manned flight after the first AAP cluster, and what is the relationship between various feasible funding levels, and progress toward major national objectives?

Lunar Exploration Program

1. What program should be undertaken for lunar exploration after the first manned lunar landing?

Planetary Exploration Program

1. What planetary program should the nation embark on?

Astronomy Program

1. What new space projects or extension of existing projects that will cost over $15 million over the next 5 years should be considered for initiation in FY70?

Space Physics Program

1. What alternative project plans should be considered for Pioneer after the planned 1973 launch, and what are the future objectives and how do they relate to objectives of other projects?

2. What are the scientific objectives to be pursued in space geophysics, and what alternative projects should be considered in FY70 as replacements for the OGO series, which will be completed in 1969?

Space Biology Program

1. What unmanned flight projects should be initiated in FY70?

2. What experiments are best conducted on manned spacecraft?

Aircraft Technology Program

1. Should the NASA Quiet Engine Project continue through fabrication and testing of a demonstration engine?

2. Should NASA maintain the current pace of research on supersonic transports?

3. What V/STOL proof-of-concept activities should be undertaken in support of the Department of Defense and the Department of Transportation?

Table 2-2

Issues for FY70 Budget

4. What projects should be initiated with the goal of improving the economy or safety of subsonic jet transport operation?

Advanced Space Technology Program

1. Should Nerva I development proceed on the present plan or be deferred until 1975 or later?

2. Should work continue on low-cost booster technology?

3. Should the SNAP-8 program be extended through combined systems test?

Space Applications Program

1. What combination of projects best meets the application program objectives?

2. Should development of an Earth resources research satellite be funded in the FY70 budget?

3. Which alternative criteria for initiating flight projects should be used in place of economic benefits?

4. How would NASA develop the agency manpower base for an expanded applications program?

5. What should be the role of NASA in the Global Atmospheric Research Project?

Supporting Activities Program

1. Should NASA build a 210-foot deep space tracking and data acquisition dish at Madrid, Spain?

2. What specific measures can be taken to hold down overseas operating costs without impairing effectiveness?

Special Launch Vehicle Group

1. During a period of prolonged austerity, how can the launch vehicle capabilities needed for a vigorous future space exploration program be preserved?

2. What is the most economical way to meet Saturn IB class mission objectives?

3. What is the most economical way to meet Saturn V class mission requirements?

4. What is the most effective family of launch vehicles to satisfy unmanned mission requirements?

5. Would the availability of an intermediate class launch vehicle permit more realistic mission planning?

Chapter 3
Interfaces

Chapter 3

PROGRAM CATEGORY INTERFACES

3.0 Introduction

This chapter identifies overlaps, interfaces and common elements between and among the various Program Categories. Throughout the chapter these inter-Program relationships are commonly referred to as "interfaces" and have been grouped into three classifications:*

Program - goals, objectives, program strategies, alternative missions/projects, issues, resources and schedules.

System - major elements of the flight ground test, development, and operational support systems.

Missions - mission profiles, precursory mission requirements, and requirements for flight support from other programs.

The interfaces between each pair of Program Categories are outlined in Figure 3.1 using abbreviated notation. Where appropriate, the interfaces are described in greater detail in Sections 3.1 through 3.7. The program elements which serve as the basis for interfaces among more than two Program Categories are identified in Section 3.8. All Program Categories except Aircraft Technology and Advanced Space Technology are included in the compilation in Sections 3.1-3.8. The former is excluded because no significant interface with other programs has been

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*It is desirable to include two additional classifications: (1) Research and Technology and (2) Management. The Program Memoranda generally do not provide sufficient information to permit a meaningful identification of interfaces in these areas.

identified. The latter is omitted because it interfaces with all programs in ways which are generally apparent from the statement of program objectives. Greater detail on SRT projects in the Program Memoranda would provide the basis for identification of significant interfaces in the area of research and technology.

3.1 Extension of Manned Space Flight Capability Program (EMSF) Interfaces

3.1.1 EMSF - Lunar Exploration

Program

- The programs have related goals and objectives in the utilization of man for space exploration and in the study of man and his capabilities in space flight. EMSF utilizes manned space flight capability to pioneer, discover, and answer important scientific, technological, and applications questions. Lunar Exploration utilizes manned space flight capability to explore the moon and for science. Both programs develop manned space flight technological capability on an expanding scale.

- The issue raised by EMSF relative to selection of the Saturn V as a launch vehicle cannot be resolved independently of consideration of the Lunar Exploration program.

- The resources of the two programs are intimately related in such areas as Mission Operations, Program Support, and maintenance of the Saturn/Apollo operational capabilities.

Missions

- The first segment of the Lunar Exploration mission profile overlaps the EMSF mission profile.

3.1.2 EMSF - Astronomy

Program

- EMSF goals and objectives are aimed at use of manned space flight capability to obtain answers to important scientific questions and to operate and maintain experiment systems. Astronomy strategies and projects include the use of manned systems.

- In the FY70-74 time frame approximately $500 million for Astronomy experiments is incorporated into the EMSF program.

- Coordinated schedules are required for the manned astronomy missions to assure successful integration of experiments.

Missions

- The Earth orbital mission profiles of Astronomy are common with those of EMSF. There is a combined mission capability that is being contemplated by both programs.

3.1.3 EMSF - Space Physics

Program

- EMSF goals and objectives are aimed at use of manned space flight capability to obtain answers to important scientific questions and to operate and maintain experiment systems. Space Physics has as a goal assessing the hazards of the space environment to spacecraft and men.

- Space Physics projects include the use of the Earth Orbiting Space Laboratory as an experiments platform.

- In the FY70-74 time frame approximately $30 million of Physics experiments is incorporated into the EMSF program.

- Coordinated schedules are required for the manned physics experiment missions to assure successful experiment integration.

Missions

- The mission profiles of Space Physics in the vicinity of the Earth overlap those of EMSF.

3.1.4 EMSF - Space Biology

Program

- EMSF goals and objectives are aimed at use of manned space flight capability to obtain answers to important scientific questions and to operate and maintain experiment systems. Space Biology seeks new fundamental biological knowledge with special attention to continuing space efforts.

- Space Biology has as an objective the survey of the effects of weightlessness on living organisms, which is related to the EMSF objective to study man's biological performance in space.

- Space Biology considers an all-manned program alternative, as well as several manned supplements to automated program alternatives.

- Space Biology raises issues on the use of manned space flight for Space Biology experiments.

- In the FY70-74 time period approximately $30 million of Space Biology experiments is incorporated into the EMSF program.

- Coordinated schedules are required for the manned biological experiment missions to assure successful experiment integration.

Missions

- The Earth orbital mission profiles overlap.

- Space Biology provides precursory information on the effects of the space environment, particularly weightlessness and radiation.

3.1.5 EMSF - Space Applications

Program

- EMSF goals and objectives are aimed at demonstrating the use of manned systems for conducting applications experiments.

- In the FY70-74 time frame approximately $70 million of Space Applications experiments is incorporated into the EMSF program.

- Coordinated schedules are required for the manned applications experiments to assure successful experiment integration.

Missions

- The mission profiles of EMSF overlap those of Space Applications for Earth Resources and possibly, Meteorology missions.

3.1.6 EMSF - Supporting Activities (Tracking and Data Acquisition)

Program

- The Tracking and Data Acquisition sub-program is considering a new data relay satellite system; which would provide support to EMSF missions.

3.2 Lunar Exploration Program Interfaces

3.2.1 Lunar Exploration - Planetary Exploration

Program

- Understanding the origin and evolution of the solar system is a common goal.
- Understanding the origin of life is a common goal.
- Understanding the dynamic processes that shape the Earth environment is a common goal.
- Studying the potential of man to function on another planet is a goal of Lunar Exploration.

3.2.2 Lunar Exploration - Astronomy

Program

- Understanding the origin and evolution of the solar system is a common goal.
- Lunar Exploration seeks to determine the potential of the lunar environment for supporting astronomy experiments.

3.2.3 Lunar Exploration - Space Physics

Program

- Understanding the origin and evolution of the solar system is a common goal.
- Understanding the dynamic processes that shape the Earth environment is a common goal.
- Lunar Exploration has as a goal the assessment of the Moon as a platform for space research.
- Space Physics has as a goal the assessment of the hazards of the space environment to spacecraft and men.

System

Lunar base and lunar orbiting spacecraft (e.g., lunar particle and fields satellite).

Missions

Mission profile in the vicinity of the moon.

3.2.4 Lunar Exploration - Space Biology

Program

- One of the Space Biology strategies concentrates on providing fundamental data related to manned spaee flight.

Missions

- Lunar mission profiles are suitable for Space Biology.

3.2.5 Lunar Exploration - Supporting Activities (Tracking and Data Acquisition)

Program

- The Tracking and Data Acquisition sub-program has a goal, "to provide adequate facilities and services to insure that tracking and data objectives of flight programs are achieved."

3.3 Planetary Exploration Program Interfaces

3.3.1 Planetary Exploration - Astronomy

Program

- Understanding the origin of the solar system is a common goal.

- The programs have related objectives. Planetary Exploration seeks to determine the composition of Planetary atmospheres. Astronomy makes spectral measurements of the planets in the ultra-violet and infra-red frequencies to determine atmospheric composition.

3.3.2 Planetary Exploration - Space Physics

Program

- Understanding the origin and evolution of the solar system is a common goal.

- Understanding the dynamic processes that shape the Earth environment is a common goal.

- Space Physics has as a goal the assessment of the hazards of the space environment to spacecraft.

Missions

- The mission profile is common to both programs, and combined missions are being studied.

3.3.3 Planetary Exploration - Space Applications

System

- The sensors being developed by Space Applications for Earth observations may be applicable to planetary orbiters.

3.3.4 Planetary Exploration - Supporting Activities (Tracking and Data Acquisition)

Program

- The Tracking and Data Acquisition sub-program has a goal, "to provide adequate facilities and services to insure that tracking and data objectives of the flight programs are achieved."

- The Tracking and Data Acquisition sub-program has an objective to increase data acquisition capability in support of the Planetary Program.

3.4 Astronomy Program Interfaces

3.4.1 Astronomy - Space Physics

Program

- Understanding the origin and evolution of the solar system is a common goal.

Missions

- The Earth-orbiting mission profiles of the two programs overlap.

3.4.2 Astronomy - Space Biology

Missions

- The Earth-orbiting mission profiles of the two programs overlap.

3.4.3 Astronomy - Space Applications

Missions

- The mission profiles overlap.

3.4.4 Astronomy - Supporting Activities (Tracking and Data Acquisition)

Program

- Tracking and Data Acquisition sub-program has a goal, "to provide adequate facilities and services to insure that tracking and data objectives of the flight programs are achieved."

3.5 Space Physics Program Interfaces

3.5.1 Space Physics - Space Biology

Program

- The objective of Space Physics to define the hazards of the space environment is related to the objective of Space Biology to survey the effects of high energy, heavy particle, and cosmic radiation on selected biological organisms.

Missions

- The mission profiles overlap.

3.5.2 Space Physics - Space Applications

Missions

- Earth-orbiting mission profiles overlap.

3.5.3 Space Physics - Supporting Activities (Tracking and Data Acquisition)

Program

- The Tracking and Data Acquisition sub-program has a goal, "to provide adequate facilities and services to insure that tracking and data objectives of the flight programs are achieved."

3.6 Space Biology Program Interfaces

3.6.1 Space Biology - Space Applications

Mission

- Earth-orbiting mission profiles overlap.

3.6.2 Space Biology - Supporting Activities (Tracking and Data Acquisition

Program

- The Tracking and Data Acquisition sub-program has a goal, "to provide adequate facilities and services to insure that tracking and data objectives of the flight programs are achieved."

3.7 Space Applications Program Interfaces

3.7.1 Space Applications - Supporting Activities (Tracking and Data Acquisition)

Program

- The Tracking and Data Acquisition sub-program has a goal, "to provide adequate facilities and services to insure that the tracking and data objectives of the flight programs are achieved."
- The geodetic and communications objectives of Space Applications support those of Tracking and Data Acquisition.

3.8 Interfaces by Common Elements

This section identifies those elements which serve as the basis for interfaces among more than two Program Categories. Such a compilation provides a partial basis for identifying omissions, inconsistencies, and errors in the program documentation.

3.8.1 Program Interfaces

- Goal/objective on utilization of man to obtain answers to important scientific, technological and applications questions: EMSF, Lunar Exploration, Astronomy, Space Physics, Space Biology, Space Applications.
- Goal/objective on obtaining fundamental data applicable to manned space flight: EMSF, Lunar Exploration, Space Biology, Space Physics.
- Goal/objective on determination of hazards of the space environment for spacecraft, man and living organisms: EMSF, Lunar Exploration, Planetary Exploration, Space Physics, Space Biology.

- Goal/objective on understanding the Earth environment: Lunar Exploration, Planetary Exploration, Space Physics.

- Goal/objective on understanding the solar system: Lunar Exploration, Planetary Exploration, Astronomy, Space Physics.

3.8.2 System Interfaces

- Titan III launch vehicle or derivative: EMSF, Lunar Exploration, Planetary.

- Thor/Delta launch vehicle or derivative: Planetary Exploration, Astronomy, Space Biology, Space Applicatinns, Space Physics.

- Atlas/Centaur launch vehicle: Planetary Exploration, Astronomy, Space Biology, Space Applications.

- Lunar Base: Lunar Exploration, Astronomy, Space Physics.

- ETR Launch Complexes 17A and B: Planetary Exploration, Astronomy, Space Biology, Space Applications, Space Physics.

- ETR Launch Complexes 36A and B: Planetary Exploration, Astronomy, Space Biology, Space Applications.

- ETR Launch Complexes 40, 41: EMSF, Lunar Exploration, Planetary Exploration.

- STADAN: Astronomy, Space Physics, Space Biology, Space Applications, Supporting Activities (T&DA).

- MSFN: EMSF, Lunar Exploration, Supporting Activities (T&DA).

- DSN: Lunar Exploration, Planetary exploration, Space Physics, Supporting Activities (T&DA).

- NASCOMM: EMSF, Lunar Exploration, Planetary Exploration, Space Physics, Space Biology, Space Applications, Astronomy, Supporting Activities (T&DA).

- National Space Science Data Center: EMSF, Lunar Exploration, Planetary Exploration, Space Physics, Space Biology, Space Applications, Supporting Activities (T&DA), Astronomy.

Figure 3-1
Interfaces

LUNAR EXPLORATION	PLANETARY EXPLORATION	ASTRONOMY
• DEVELOPMENT AND UTILIZATION OF MAN'S CAPABILITY IN SPACE. FUTURE OF SATURN V LAUNCH VEHICLE. RESOURCES • CM, SM, AND DERIVATIVES SAT V, SAT IB, T-III, AND DERIV. ETR 34, 37, 39, 40, 41 MSFN, MCC • MISSION PROFILE P.3.1.1	• • LAUNCH VEHICLE (T-III) OR DERIVATIVE ETR 40, 41 •	• MAN SUPPORTING SCIENCE RESOURCES SCHEDULES • EOSL, ATM, • MISSION PROFILE COMBINED MISSIONS P.3.1.2
	• UNDERSTAND EARTH ENVIRONMENT UNDERSTAND SOLAR SYSTEM UNDERSTAND ORIGIN OF LIFE FUNCTIONING OF MAN ON PLANET • S/C DERIVATIVES T-III AND DERIVATIVES ETR 40,41 • P.3.2.1	• LUNAR BASE FOR ASTRONOMY UNDERSTAND SOLAR SYSTEM • LUNAR BASE • P.3.2.2
		• UNDERSTAND SOLAR SYSTEM UNDERSTAND PLANET SURF. & ATMOS. • DELTA, ATLAS/CENTAUR, ETR 17 A/B, 36 A/B • P.3.3.1

KEY

- PROGRAM INTERFACES
- SYSTEM INTERFACES
- MISSIONS INTERFACES

NOTES:

1. INTERFACES BETWEEN PROGRAM CATEGORIES ARE IDENTIFIED IN GROUPS CLASSIFIED AS SHOWN IN KEY ABOVE
2. PROGRAM CATEGORIES NOT SHOWN ARE AIRCRAFT TECHNOLOGY AND ADVANCED SPACE TECHNOLOGY.
3. INTERFACES RESULTING FROM COMMON USE OF T & DA FACILITIES AND NETWORKS ARE SHOWN ONLY IN THE COLUMN "SUPPORTING ACTIVITIES (T&DA)"
4. P. INDICATES NUMBER OF CORRESPONDING SECTION IN TEXT
5. ETR NUMBERS ARE LAUNCH COMPLEXES AT EASTERN TEST RANGE

FIGURE 3-1

	SPACE PHYSICS	SPACE BIOLOGY	SPACE APPLICATIONS	SUPPORTING ACTIVITIES (T & DA)	
3.1.2	• HAZARDS TO S/C & MEN MAN SUPPORTING SCIENCE RESOURCES SCHEDULES • EOSL • MISSION PROFILE COMBINED MISSIONS P.3.1.3	• EFFECTS OF WEIGHTLESSNESS MAN SUPPORTING SCIENCE MANNED FLTS. OF OPPORTUNITY RESOURCES SCHEDULES • EOSL • MISSION PROFILE COMBINED MISSIONS P.3.1.4	• MAN SUPPORTING APPLICATIONS RESOURCES SCHEDULES • EOSL • MISSION PROFILE COMBINED MISSIONS P.3.1.5	• DATA RELAY SAT. SYST • MSFN NASCOMM-MCC DATA CENTER EOSL COMMUNICATIONS AND DATA LINK • P.3.1.6	EMSF
3.2.2	• LUNAR BASE UNDERSTAND EARTH ENVIRONMENT UNDERSTAND SOLAR SYSTEM ASSESS HAZARDS OF SPACE • LUNAR BASE LUNAR ORBITING S/C • M[illegible] PROFILE P.3.2.3	• FUNDAMENTAL MSF DATA • S/C • MISSION PROFILE P.3.2.4	• • •	• T&DA SUPPORT • MSFN, DSN NASCOMM-MCC DATA CENTER S/C COMMUNICATION AND DATA LINK • P.3.2.5	LUNAR EXPLORATION
IS. 3.3.1	• UNDERSTAND SOLAR SYSTEM UNDERSTAND EARTH ENVIRONMENT ASSESS HAZARDS OF SPACE • S/C DELTA ETR 17 A/B • MISSION PROFILE COMBINED MISSIONS P.3.3.2	• • DELTA, ATLAS/CENTAUR ETR 17 A/B, 36 A/B •	• • REMOTE SURFACE SENSORS DELTA ETR 17 A/B • P.3.3.3	• T&DA SUPPORT • DSN NASCOMM DATA CENTER S/C COMMUNICATION AND DATA LINK • P.3.3.4	PLANETARY EXPLORATION
	• UNDERSTAND SOLAR SYSTEM • DELTA ETR 17 A/B • MISSION PROFILE P.3.4.1	• • DELTA, ATLAS/CENTAUR ETR 17 A/B, 36A/B • MISSION PROFILE P.3.4.2	• • DELTA, ATLAS/CENTAUR ETR 17 A/B, 36 A/B • MISSION PROFILE P.3.4.3	• T&DA SUPPORT • STADAN NASCOMM DATA CENTER S/C COMMUNICATION AND DATA LINK • P.3.4.4	ASTRONOMY
		• HAZARDS OF SPACE ENVIRONMENT • S/C DELTA ETR 17 A/B • MISSON PROFILE EARTH ORBIT P.3.5.1	• • DELTA ETR 17 A/B • MISSION PROFILE EARTH ORBIT P.3.5.2	• T&DA SUPPORT • DSN STADAN, NASCOMM DATA CENTER S/C COMMUNICATION AND DATA LINK • P.3.5.3	SPACE PHYSICS
			• • DELTA, ATLAS/CENTAUR ETR 17 A/B, 36 A/B • MISSION PROFILE P.3.6.1	• T&DA SUPPORT • STADAN NASCOMM DATA CENTER S/C COMMUNICATION AND DATA LINK • P.3.6.2	SPACE BIOLOGY
				• GEODESY, COMMUNICATIONS T & DA SUPPORT • STADAN NASCOMM DATA CENTER • P.3.7.1	SPACE APPLICATIONS

E 3-1 PROGRAM CATEGORY INTERFACES

Chapter 4
Strategies

Chapter 4

NASA PROGRAM STRATEGIES

4.0 Introduction

This chapter examines and elaborates upon Agency program strategies for meeting Agency goals and objectives. The intent is to provide a basis for the synthesis of NASA program alternatives by defining strategies which are (1) individually acceptable as conceptual approaches for achievement of Agency goals and objectives, (2) collectively suitable for the program synthesis process, and (3) generally compatible with the programs being developed by the Program Category Working Groups and with the annual Agency funding levels being considered by the Planning Steering Group, $3.5, $3.8 and $4.1 billion.

4.1 Agency Goals and Objectives

The national requirements which can be at least partially fulfilled by aeronautical and space activities within the scope of NASA's enabling legislation are identified in Table 4-1. The first three sets of requirements were derived from the President's 1968 Budget Message to Congress; the fourth is considered implicit for any technologically-oriented society. The Agency goals selected to guide the Agency in planning its contribution toward the fulfillment of national requirements are also shown in Table 4-1, matched with the requirements with which they are associated. The Agency objectives are not defined in this report. Selection of the FY70 Program as the culmination of the activity in this planning cycle will in effect identify the objectives to serve as the point of departure for the next planning cycle.

4.2 Program Strategies

At the specified funding levels, the spectrum of options available in developing alternative Agency programs is bounded by two major themes:

a. Emphasize the conquest of space through bold, imaginative projects which reflect the American pioneer spirit, enhance the national image and prestige, capture the public imagination, and advance our national technological capability and

b. Emphasize the returns of space activity through projects which can show direct benefits to the taxpayer and to the people of the world; acquire scientific data useful not only for answering the major scientific questions of our times, but also for enabling us to understand and control our environment, and advance our national technological capability.

Between these two extremes a balanced program can be formulated which would make steady, but perhaps unspectacular, progress along a broad front toward all goals. The relative position of the balanced program depends on the minimum effort required to sustain each of the Program Categories supporting the Agency goals.

The foregoing discussion forms the basis for the selection of three basic Agency strategies referred to as "Conquest of Space," "Balanced," and "Returns of Space Activity." In Table 4-2 the characteristics of each are outlined and elaborated upon in terms of implementing strategies for the individual Program Categories.

4.3 Analysis of Agency Strategies

Evaluation of the three strategies identified above against the criteria specified in Section 4.0 yields the following results.

• Acceptability. All three are acceptable in that they directly support or permit attainment of all the goals. While they emphasize different aspects of space activity, none of them precludes the attainment of any Agency goal. As the Agency objectives are defined, it will probably be shown that their achievement varies with strategy. But then, selection of a strategy at a given funding level is tantamount to a selection of objectives.

• Suitability. The strategies generally offer competitive, and comparable approaches. At a given funding level consideration of three programs can be readily accommodated by management. The increase to nine programs, resulting from three funding levels, tends to make the evaluation task difficult, and it appears desirable to reduce that number, if possible, through imposition of additional selection criteria. It may be that a "conquest" strategy at the $3.5 billion/year level and a "returns" strategy at $4.1 billion/year are not entirely meaningful options.

• Compatibility. The program alternatives described in the Program Memoranda generally are of sufficient scope to permit the synthesis of Agency programs reflecting the theme of each of the strategies. It can be concluded that qualitatively the Program Memoranda and Agency strategies are mutually compatible.

Review of the funding requirements of each of the program categories, however, reveals that, except for a few cases, sufficiently austere options are not presented. A simple addition of the fiscal requirements of the most austere alternative of each category leads to a total of more than $3.9 billion for FY70. The remaining years lie between $3.6 and $3.8 billion, but this low level is achieved primarily because the minimum Lunar Exploration program is one which requires no further procurement of Saturn-Apollo hardware.

The handling of the $3.5 billion level program is further complicated by the fact that the run-out of FY69 and prior year decisions has an estimated funding requirement of $3.68 billion for FY70. Compatibility with this strategy constraint would require that the Program Memoranda include alternatives which are based on cancellation of current decisions. Further cancellation would be required to permit the introduction of new starts.

Table 4-1
Goals

TABLE 4-1

NATIONAL REQUIREMENTS AND AGENCY GOALS

National Requirements	Agency Goals
A. Maintain the national security • Provide the forces essential for national defense. • Promote a peaceful world community in which all nations can devote their energies toward improving the lives of their citizens.	1. Support development of aeronautics and space technology and capability to meet military requirements. 2. Demonstrate and maintain technological strength in aeronautics and space. 3. Cooperate with other nations in space activity.
B. Enhance the general welfare • Strengthen our economic base and continue our economic growth. • Solve major national social and economic problems relating to law and order, transportation, urban development, poverty, etc.	4. Develop aeronautics and space technology and capability to provide direct economic benefits to the Nation. 5. Develop large-project management techniques which may be applied to solution of major national social and economic problems.
C. Expand our human knowledge and capability • Expand our scientific knowledge. • Develop the skills and talents of our people.	6. Expand our scientific knowledge of the atmosphere and space. 7. Provide a focal point for the development of scientists and engineers.
D. Advance the national technology in general and provide the base for continued growth in national capability	8. Advance the national aeronautics and space technology and capability.

Table 4-2
Strategies

TABLE 4-2

ELABORATION OF AGENCY STRATEGIES

	Conquest of Space	Balanced	Returns of Space Activity
GENERAL	Emphasize development of capability to meet new challenges and ensure preeminence.	Continue present balance of agency goals.	Emphasize utilization of existing capability to support data-gathering in applications and science.
	Use man as an explorer.	Maintain future options for both "Conquest" and "Returns" projects in earth orbit, lunar and planetary areas.	Use man to enhance returns.
	Assign priority to examination of "new" areas in science and applications.		Assign priority to development of areas where benefit is assured in science and applications.
	Develop technology to extend performance.		Develop technology to improve cost effectiveness.
	Assume next major objective will be selected in early 70's.	Assume next major objective may be selected early but acknowledge "slip" possibilities.	Assume next major objective is sufficiently remote that it should not constrain program.
	Make necessary decisions to permit effective funding of new starts.	Accept some cost penalty to maintain future options.	Make necessary decisions to permit effective funding of "Returns" projects.
PROGRAM CATEGORY EMPHASIS			
EMSF	Extend manned earth orbital capability to provide basis for the next major new start. Conduct an experiment program to define man's long term capability in space.	Develop and apply as possible the potential of manned space flight for science and applications, emphasizing the development of experience and capability required to support the next major new start. Initial focus of the experiment program is on determining man's capability in long duration operations.	Develop and apply the potential of manned space flight for economic and social benefits and science. Extend manned space flight capability in the direction that lowers the cost of these orbital applications.
Lunar Exploration	Provide the data and operational experience required to support the decision on the future lunar program.	Same as "Conquest".	Develop the knowledge required to evalugte the moon for potential science and applications returns.
Planetary Exploration	Acquire the near planet data which is prerequisite to a decision on manned planetary exploration.	Pursue acquisition of initial data on all the planets.	Emphasize multidisciplinary scientific return from all planets.
Astronomy	Pursue an evolution to manned astronomy.	Pursue all astronomy disciplines (stellar, solar, x- and γ-ray, radio) in a program designed to provide manned astronomy at a later date.	Pursue all astronomy disciplines (stellar, solar, x- and γ-ray, radio) that promise effective return.
Space Physics and Space Biology	Adjusted to fit the funding constraints in all three strategies - selection criterion for projects is that the project either provides the potential for a breakthrough experiment or provides a needed stimulus to the discipline.		
Aircraft Technology	Level of effort.	Level of effort.	Increase emphasis on direct return projects.
Advanced Space Technology	Emphasize mission oriented studies leading to extended duration manned flight.	Level of effort.	Emphasize mission oriented studies leading to lower cost carrier systems.
Space Applications	Pursue projects which are responsive to needs of user government agencies for new space capability.	Same as "Conquest".	Same as "Conquest" plus pursue exploratory projects that show a potential for direct economic and social benefits.
Supporting Activities (T & DA)	Level of effort. Additional capability required to support a particular program category to be identified and justified by that program category.		

Chapter 5
Alternatives

Chapter 5

NASA PROGRAM ALTERNATIVES

5.0 Introduction

This chapter summarizes the results of the synthesis of NASA program alternatives to implement the program strategies defined in Section 4.2. The point of departure for the synthesis process is the Baseline Program, which is derived from the "FY 1969 Interim Operating Budget with Runout Implications" distributed by the Assistant Administrator for Administration's memorandum dated August 16, 1968. The elements of the Baseline Program and their funding requirements are shown in Table 5-1.

5.1 Agency Program Selection

In selecting the Agency program alternatives which are eventually to undergo characterization and evaluation, three basic criteria were considered: feasibility, utility/suitability, and acceptability. The principal questions to be answered under each of these criteria have been defined as:

- Feasibility

1. Is the funding within the limit adopted for program planning?

2. Is the program in each Category technologically feasible?

3. Are planned tracking and data acquisition facilities adequate for the total program?

4. Are planned ground test facilities adequate for the total program?*

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*For this analysis complete data on ground test facilities was not available. It is necessary to assume a "yes" for all programs.

5. Are planned launch facilities adequate for the total program?

6. Can NASA and contractor manpower requirements be met?*

- Utility/Suitability

1. Does the program in each Category support the Agency strategy under which it is being considered?

- Acceptability

1. Are the programs in each Category and the total program compatible with Agency policy?**

5.2 Approach

The synthesis process generated Agency programs which implement at three funding levels each of the strategies elaborated upon in Chapter 4.

Initial effort was applied to the development of a program for the "Balanced" strategy at the $3.8 billion funding level. In each Program Category, Program Memorandum options which support the various strategies specified in Table 4-2 were identified and their FY70 new start projects were determined. As noted earlier, the sum of the FY70 requirements for the most austere options of the Categories exceeded $3.9 billion. Hence, it was necessary to adjust Program Memorandum options to bring the FY70 total to the required level. With a Baseline Program of $3.68 billion in FY70, the new start increment had to be held to approximately $120 million. In order to make maximum use of the Program Memorandum data, no effort was made to maintain a constant funding level throughout the five-year program.

At the $3.8 billion level, programs under the "Conquest" and "Returns" strategies were developed by appropriate shifts in emphasis, using the Category programs selected under the "Balanced" strategy as points of departure. The basis for the program selected under each Category for each strategy is identified in strategy/funding transfer Table 5-2.

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*Analysis of manpower requirements is outside the scope of this report. A "yes" is assumed for all programs.

**For this analysis a "yes" is assumed for all programs unless some apparently obvious violation of policy is uncovered.

The program alternatives at the $3.5 and $4.1 billion funding levels were developed by treating the $3.8 billion programs as benchmarks. Within each strategy the benchmarks were adjusted upward or downward to reflect the funding level while generally maintaining the theme of the strategy. Program Memorandum data was used where possible and principal attention was devoted to the FY70 funding requirements. At the $3.5 billion level, it was necessary to introduce cancellation of decisions made in FY69 or prior years in order to reduce the Baseline Program. Additional cancellations were necessary to permit new starts in FY70. Estimates of the fiscal changes associated with program cancellations were obtained generally through participation in PSG Synthesis Group activity.

The programs developed to meet the funding constraints were analyzed to determine the adequacy of the planned tracking and data acquisition and launch facilities.*

5.3 Program Alternatives

The Agency program alternatives selected for characterization are outlined in terms of funding requirements in Tables 5-3 to 5-13, inclusive, and in terms of planning launch schedules in Tables 5-14 to 5-16, inclusive. Except for the funding summary in Table 5-13, funding requirements are stated as variations with respect to the Baseline Program. The funding tables cover fiscal years 1970-74; the launch schedule tables calendar 1969-74. The projects included in the various programs are described briefly in Appendix I.

5.4 Commentary on Funding

In general, funding requirements are stated in terms of line items identified in the FY 1969 Interim Operating Budget and in the Program Memoranda. In the case of OMSF funding, however, it was found convenient to introduce an additional category to clarify the funding of the EMSF and Lunar Exploration programs.

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*Examination of these areas was somewhat cursory. However, it was ascertained that the third 210-foot DSN antenna would be available when required for 1973 planetary missions and that the other tracking networks would generally accommodate the mission models considered. With regard to launch facilities, Saturn launches are within the planned capability, the required Titan III facilities are covered by funding, and the unmanned launches appear to be feasible without facility augmentation. No consideration was given to the effects on launch facilities of terminating Saturn launches.

A line item entitled "OMSF Common" has been added to include the funding associated with Apollo, the Apollo Applications Program, Supporting Development/Advanced Missions, Mission Operations, Program Support, Contract Administration, and maintenance of the Saturn/Apollo operational capability. All EMSF experiments and experiment definition items were combined into a single line item, and where other Program Categories identified requirements associated with manned experiments, they are carried in the programs of those Categories as non-add entries. The remaining items under the EMSF and Lunar Exploration Programs represent the program-peculiar requirements.

TABLE 5-1
FUNDING REQUIREMENTS - BASELINE PROGRAM
(IN MILLIONS OF DOLLARS)

PROGRAM CATEGORY/PROJECT	FY69	70	71	72	73	74
OMSF COMMON	2171	1926	1057	192	75	10
APOLLO PROGRAM	2007	1540	792			
ADVANCED MISSIONS	2	10	10	10	10	10
APOLLO APPLICATIONS PROG.	143	345	225	182	65	
SUPPORTING DEVELOPMENT	18	30	30			
LUNAR EXPLORATION	14	5	5	5	5	5
PLANETARY EXPLORATION	81	122	134	151	99	44
BASE	21	20	20	20	20	20
MARINER - MARS 1969	32	4				
MARINER - VENUS 1967	1	1				
PIONEER F & G	2	14	14	17	9	3
TITAN - MARS 1973	(6)	30	69	111	70	20
MARINER - MARS 1971	26	53	31	3		
ASTRONOMY	82	75	38	25	21	19
DATA ANALYSIS/SRT/ADVANCED STUDIES	10	10	10	10	10	10
OSO A-H	14	11	6	2		
OAO A-C	42	34	8	2	1	
RAE A-B	2	1				
SAS A	4	4	1	1		
SOUNDING ROCKETS	10	10	10	10	10	10
SAS B	1	4	4	1	1	
SPACE PHYSICS	64	62	46	36	27	25
SRT/ADVANCED STUDIES/DATA ANALYSIS	14	14	14	14	14	14
SAN MARCO	1	2				
PIONEER A-E	5	4	2			
OGO A-F	14	6	2			
SSS A-B	2	6	4	1		
OWL A-B	2	2	1			
IMP A-J	9	9	5	4	1	
AD/I A-C	1	1				
ISIS X, I, A-C	4	4	2	2		
GERMAN I	1	1				
SOUNDING ROCKETS	10	10	10	10	10	10
SUNBLAZER A-E	1	4	6	4	1	
SPACE BIOLOGY	30	40	39	24	15	7
SRT	7	7	7	7	7	7
BIOSATELLITE (A-F)	23	33	32	17	8	

PROGRAM CATEGORY/PROJECT	FY69	70	71	72	73	74
SPACE APPLICATIONS	109	123	109	95	65	47
SRT/ADVANCED STUDIES	20	20	20	20	20	20
TIROS/TOS IMPROVEMENTS	6	4	3	2	2	2
NIMBUS A-F	40	43	28	20	10	3
METEOROLOGICAL SOUNDINGS	3	3	3	3	3	3
ATS A-G	27	44	49	43	23	13
GEOS	2	2				
INTERNATIONAL APPLICATIONS SATELLITE	1	2				
EARTH RESOURCES SURVEY AIRCRAFT PROGRAM	9	6	6	6	6	6
ERTS	2					
ADVANCED SPACE TECHNOLOGY	176	158	150	150	150	150
SPACE POWER & ELECTRICAL PROPULSION	42	34	33	33	33	33
NUCLEAR ROCKETS	25	15	10	10	10	10
CHEMICAL PROPULSION	27	27	27	27	27	27
SPACE VEHICLE SYSTEMS	31	31	30	30	30	29
ELECTRONIC SYSTEMS	21	20	20	20	20	20
HUMAN FACTORS SYSTEMS	17	17	17	17	17	17
BASIC RESEARCH	14	14	14	14	14	14
OSSA	3					
AIRCRAFT TECHNOLOGY	95	98	94	76	70	70
SRT/ART/OTHER TECHNOLOGY	60	62	62	62	62	62
XB-70	5					
V/STOL	8	8	8	8	8	8
HYPERSONIC RESEARCH ENGINE	6	2	3	3		
AIRCRAFT NOISE	8	4				
QUIET ENGINE	8	20	20	2		
SUPPORTING ACTIVITIES	1053	1073	1063	1080	1092	1097
CONSTRUCTION OF FACILITIES	36	15	2			
ADMINISTRATIVE OPERATIONS	650	680	685	690	695	700
TECHNOLOGY UTILIZATION	4	4	4	4	4	4
UNIVERSITY PROGRAM	9	9	9	9	9	9
TRACKING AND DATA ACQUISITION	280	298	306	319	326	326
STEP FUNDING	15					
LAUNCH VEHICLES	59	67	58	57	57	57
TOTAL	3874	3681	2735	1833	1619	1473

TABLE 5-2
STRATEGY/FUNDING TRANSFERS

Program Category	Conquest of Space	Balanced	Returns of Space Activity
$4.1 Billion/Year			
EMSF	PM Option III, with $45M/yr additional for Supporting Development/Advanced Missions and $150M/yr in FY70/71 for backup AAP hardware.	PM Option III.	PM Option I.
Lunar Exploration	PM Plan 3B with activity gapped in 1972.	PM Plan 3A.	(*)
Planetary Exploration	PM "Mars Emphasis" program ($350M/yr level) plus $20M/yr increase in SRT commencing FY70.	PM "Balanced" program ($350M/yr level).	PM "Balanced" program ($350M/yr level) with '73 and '75 Venus flybys slipped two years.
Astronomy	PM Alternative 3.	PM Alternative 2.	(*)
Space Physics	PM Alternative 3.	PM Alternative 2.	(*)
Space Biology	PM Plan A.	PM Plan C.	(*)
Aircraft Technology	(*)	PM Plan I.	PM Plan 2.
Advanced Space Technology	(*)	PM level I.	(*)
Space Applications	PM Program 3 with Earth Resources FY70 new starts and ATS H and J slipped one year.	PM Program 2.	PM Program I.
Supporting Activities (T & DA)	(*)	Baseline as amended by PSG Benchmark data.	(*)
$3.8 Billion/Year			
EMSF	(*)	PM Option III.	PM Option I.
Lunar Exploration	PM Plan 3B with activity gapped in 1972.	PM Plan 3A with activity gapped in 1972.	PM Plan 3A with activity gapped in 1972. No Saturn V beyond SA-515.
Planetary Exploration	PM "Mars Emphasis" program ($350M/yr level).	PM $200M Balanced Program.	(*)
Astronomy	Same as "Balanced" except that ATM after ATM-A is included. ATM funded under EMSF.	PM Alternative 2 with OAO D and E and OSO I, J, and K slipped one year. ATM after ATM-A not included. Orbital Workshop Scientific Experiments funded under EMSF. SRT, Sounding Rockets, Data Analysis and Advanced Studies at Baseline level until FY72.	(*)
Space Physics	PM Program Alternative 3 with new starts slipped one year.	PM Program Alternative 3.	(*)
Space Biology	PM Plan A less new starts.	PM Plan A.	(*)
Aircraft Technology	(*)	PM Plan I.	(*)
Advanced Space Technology	(*)	Level of effort at $260M/yr.	(*)
Space Applications	(*)	PM Program 3 less TDRSS: Earth Resources FY70 new starts and ATS H and J slipped one year.	PM Program 2 except Communications program number 3.
Supporting Activities (T & DA)	(*)	Baseline as amended by PSG Benchmark data.	(*)
$3.5 Billion/Year			
EMSF	(*)	PM Option III with SA 514/515 in place of INT-21. Cancel ATM and SA 213/214	PM Option I.
Lunar Exploration	(*)	PM Plan 1B with activity gapped in 1972. SA 514/515 transferred to EMSF.	PM Plan 1B with activity gapped in 1972. Defer procurement of SA 514/515.
Planetary Exploration	PM "Mars Emphasis" program ($200M/yr level) with FY70 SRT at FY69 level.	PM $200M Balanced program with FY70 SRT at FY69 level.	PM $200 Balanced program.
Astronomy	(*)	PM Alternative 2 with OAO D and E and OSO I, J, and K slipped one year. ATM after ATM-A not included. Orbital Workshop Scientific Experiments funded under EMSF. SRT, Sounding Rockets, Data Analysis and Advanced Studies at Baseline level until FY72.	(*)
Space Physics	Same as "Balanced", except cancel Sunblazer.	PM Alternative 3 with new starts slipped one year.	(*)
Space Biology	(*)	PM Plan A less new starts. Cancel '71/72 Biosatellites.	PM Plan A.
Aircraft Technology	(*)	PM Plan I commencing FY71.	(*)
Advanced Space Technology	(*)	Level of effort at $250M/yr.	(*)
Space Applications	Same as "Balanced", except slip GEOS one year.	PM Program 3 less TDRSS: Earth Resources FY70 new starts and ATS H and J slipped one year.	PM Program 3.
Supporting Activities (T & DA)	Same as "Balanced", except cancel Sunblazer Array.	Baseline as amended by PSG Benchmark data.	(*)

(*) Same as "Balanced" strategy at same funding level.

Tables 5-3/5-13
Funding

TABLE 5-3
FUNDING REQUIREMENTS ABOVE BASELINE
(IN MILLIONS OF DOLLARS)
$3.8 BILLION/YEAR LEVEL - "BALANCED" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON		175	700	700	675
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
EMSF	38	166	563	905	947
SATURN IB		13	67	110	110
EXPERIMENTS	10	91	145	168	136
PROGRAM DEFINITION	28				
INT 21		13	85	109	49
MISSION OPERATIONS				6	76
LAB. AND EXP. MOD.		45	102	159	276
NEW LOGISTIC S/C		4	164	353	300
LUNAR EXPLORATION	9	115	626	851	742
BASIC SCIENCE/PROJ. DEV.	6	15	15	15	43
PHASE C	3	8			
EXTENDED APOLLO		50	209	146	83
AUTO ORBITER		6	70	75	27
AUTO SURF. VEHICLE		36	165	247	182
SATURN V PROCUREMENT			10	144	168
CSM PROCUREMENT			17	84	98
LM PROCUREMENT			140	140	140
PLANETARY EXPLORATION	22	50	100	119	161
SRT	11	19	20	18	14
73 MARS EXPLORER		5	17	8	3
75 MARS EXPLORER				5	17
77 MARS ROUGH LANDER				3	15
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
75 VENUS FLYBY			17	42	54
73 MERCURY/VENUS SWINGBY	3	14	29	22	12
77 - 78 GRAND TOUR					9
76 COMET D'ARREST				10	32
ASTRONOMY	5	34	61	72	84
SOUNDING ROCKETS, SRT		5	5	5	5
OSO (I-K)	1	3	8	11	16
OAO (D-E)		15	24	23	25
EXPLORERS	2	9	22	30	35
AIRPLANE OBSERVATORY	2	2	2	3	3

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS	12	21	31	35	38
EARTH ENVIRONMENT	7	13	14	18	19
INTERPLANETARY	2	4	4	4	5
SPACE LAB			3	5	9
LAUNCH VEHICLES	3	4	10	8	5
SPACE BIOLOGY	2	8	26	34	26
BIOSATELLITES (G-I)	1	5	20	24	19
BIOPIONEER (A-B)	1	3	6	9	7
AIRCRAFT TECHNOLOGY	27	46	76	96	111
ADVANCED SPACE TECHNOLOGY	18	110	110	110	110
SPACE POWER & ELEC PROP	6	22	22	22	22
NUCLEAR PROPULSION	-5				
CHEMICAL PROPULSION	7	28	28	28	28
SPACE VEHICLES		8	8	8	8
ELECTRONIC SYSTEMS	6	29	29	29	29
HUMAN FACTORS	4	18	18	18	18
BASIC RESEARCH		2	2	2	2
LAUNCH VEHICLES		3	3	3	3
SPACE APPLICATIONS	5	35	70	70	75
SRT/AAFE	1	10	11	5	5
NIMBUS (A-F)		-4	-4	4	5
SYN MET		9	8	1	
WWW		5	20	14	2
LOW ALT EQ			1	4	19
ERS A/C		3	3	3	3
ERTS (A-B)		2	13	13	9
ERS LIM. OBJ. (A-B)		6	4	1	
ERS LIM. OBJ. (C-D)			2	3	4
ATS (H-J)			10	20	26
GEOS C	4	4	2	2	2
SUPPORTING ACTIVITIES	17	19	33	10	10
TRACKING AND DATA ACQUISITION	17	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-4

FUNDING REQUIREMENTS ABOVE BASELINE

(IN MILLIONS OF DOLLARS)

$3.8 BILLION/YEAR LEVEL - "CONQUEST" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON		175	700	700	675
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
EMSF	38	166	563	905	947
SATURN IB		13	67	110	110
EXPERIMENTS	10	91	145	168	136
PROGRAM DEFINITION	28				
INT 21		13	85	109	49
MISSION OPERATIONS				6	76
LAB. AND EXP. MOD.		45	102	159	276
NEW LOGISTIC S/C		4	164	353	300
LUNAR EXPLORATION	9	111	449	633	731
BASIC SCIENCE/PROJ. DEV.	6	15	15	15	43
PHASE C	3	4	3	2	
EXTENDED APOLLO		92	220	117	70
AUTO ORBITER			44	131	212
AUTO SURF. VEHICLE					
SATURN V PROCUREMENT			10	144	168
CSM PROCUREMENT			17	84	98
LM PROCUREMENT			140	140	140
PLANETARY EXPLORATION	50	138	231	267	335
SRT, DATA ANALYSIS	19	28	31	35	35
73 MARS MARINER ORBITER		13	27	22	5
75 MARS EXPLORER				5	17
75 MARS ORBITER/LANDER		18	52	89	128
77 MARS ORBITER/LANDER				25	41
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
73 VENUS FLYBY/PROBES	20	52	69	34	3
75 VENUS EXPLORER				4	13
73 MERCURY/VENUS SWINGBY	3	14	29	22	12
75 MERCURY/VENUS SWINGBY			6	11	30
77-78 GRAND TOUR					15
76 COMET D'ARREST			8	10	32
ASTRONOMY	5	34	61	72	84
SOUNDING ROCKETS, SRT		5	5	5	5
OSO (I-K)	1	3	8	11	16
OAO (D-E)		15	24	23	25
EXPLORERS	2	9	22	30	35
AIRPLANE OBSERVATORY	2	2	2	3	3

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS		12	21	31	35
EARTH ENVIRONMENT		7	13	14	18
INTERPLANETARY		2	4	4	4
SPACE LAB				3	5
LAUNCH VEHICLES		3	4	10	8
SPACE BIOLOGY	-	-	-	-	-
AIRCRAFT TECHNOLOGY	27	46	76	96	111
ADVANCED SPACE TECHNOLOGY	18	110	110	110	110
SPACE POWER & ELEC PROP	6	22	22	22	22
NUCLEAR PROPULSION	-5				
CHEMICAL PROPULSION	7	28	28	28	28
SPACE VEHICLES		8	8	8	8
ELECTRONIC SYSTEMS	6	29	29	29	29
HUMAN FACTORS	4	18	18	18	18
BASIC RESEARCH		2	2	2	2
LAUNCH VEHICLES		3	3	3	3
SPACE APPLICATIONS	5	35	70	70	75
SRT/AAFE	1	10	11	5	5
NIMBUS (A-F)		-4	-4	4	5
SYN MET		9	8	1	
WWW		5	20	14	2
LOW ALT EQ			1	4	19
ERS A/C		3	3	3	3
ERTS (A-B)		2	13	13	9
ERS LIM. OBJ. (A-B)		6	4	1	
ERS. LIM. OBJ. (C-D)			2	3	4
ATS (H-J)			10	20	26
GEOS C	4	4	2	2	2
SUPPORTING ACTIVITIES	17	19	33	10	10
TRACKING AND DATA ACQUISITION	17	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-5
FUNDING REQUIREMENTS ABOVE BASELINE
(IN MILLIONS OF DOLLARS)
$3.8 BILLION/YEAR LEVEL - "RETURNS" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON		175	700	700	675
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
EMSF	38	234	474	702	801
SATURN IB		124	150	103	96
LAB		2	89	222	203
QCM & LOG MOM			53	185	270
EXPERIMENTS	10	108	182	184	138
MISSION OPERATIONS				8	94
PROGRAM DEFINITION	28				
LUNAR EXPLORATION	9	115	459	483	336
BASIC SCIENCE/PROJ. DEV.	6	15	15	15	43
PHASE C	3	8			
EXTENDED APOLLO		50	209	146	83
AUTO ORBITER		6	70	75	27
AUTO SURF VEHICLE		36	165	247	182
PLANETARY EXPLORATION	22	50	100	119	161
SRT	11	19	20	18	14
73 MARS EXPLORER		5	17	8	3
75 MARS EXPLORER				5	17
77 MARS ROUGH LANDER				3	15
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
75 VENUS FLYBY			17	42	54
73 MERCURY/VENUS SWINGBY	3	14	29	22	12
77-78 GRAND TOUR					9
76 COMET D'ARREST				10	32
ASTRONOMY	5	34	61	72	84
SOUNDING ROCKETS, SRT		5	5	5	5
OSO (I-K)	1	3	8	11	16
OAO (D-E)		15	24	23	25
EXPLORERS	2	9	22	30	35
AIRPLANE OBSERVATORY	2	2	2	3	3

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS	12	21	31	35	38
EARTH ENVIRONMENT	7	13	14	18	19
INTERPLANETARY	2	4	4	4	5
SPACE LAB			3	5	9
LAUNCH VEHICLES	3	4	10	8	5
SPACE BIOLOGY	2	8	26	34	26
BIOSATELLITES (G-I)	1	5	20	24	19
BIO PIONEER (A-B)	1	3	6	9	7
AIRCRAFT TECHNOLOGY	27	46	76	96	111
ADVANCED SPACE TECHNOLOGY	18	110	110	110	110
SPACE POWER & ELEC PROP	6	22	22	22	22
NUCLEAR PROPULSION	-5				
CHEMICAL PROPULSION	7	28	28	28	28
SPACE VEHICLES		8	8	8	8
ELECTRONIC SYSTEMS	6	29	29	29	29
HUMAN FACTORS	4	18	18	18	18
BASIC RESEARCH		2	2	2	2
LAUNCH VEHICLES		3	3	3	3
SPACE APPLICATIONS	52	90	148	185	196
SRT/AAFE	16	18	19	7	7
SYN MET	9	8	1		
ERS A/C	4	4	4	4	4
ERS LIM. OBJ. (A-B)	6	4	1		
ERTS (A-B)	10	13	9	9	5
GEOS (C-D)	5	8	5	3	3
WWW	2	8	36	29	8
TIROS		5	11	9	2
ATS (H-J)		10	20	26	32
TDRSS		12	28	50	46
LOW ALT EQ.			1	4	24
NIMBUS (G-H)			1	4	25
ATS MET			10	7	5
ERS LIM. OBJ (C-D)			2	3	4
ERS ISE			2	11	11
NAV/TR CONTROL			3	19	20
SUPPORTING ACTIVITIES	17	19	33	10	10
TRACKING AND DATA ACQUISITION	17	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-6
FUNDING REQUIREMENTS ABOVE BASELINE
(IN MILLIONS OF DOLLARS)
$4.1 BILLION/YEAR LEVEL - "BALANCED" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON		175	700	700	675
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
EMSF	38	166	563	905	947
SATURN IB		13	67	110	110
EXPERIMENTS	10	91	145	168	136
PROGRAM DEFINITION	28				
INT 21		13	85	109	49
MISSION OPERATIONS				6	76
LAB. AND EXP. MOD.		45	102	159	276
NEW LOGISTIC S/C		4	164	353	300
LUNAR EXPLORATION	111	626	851	742	804
BASIC SCIENCE/PROJ. DEF.	15	15	15	43	43
PHASE C	8				
EXTENDED APOLLO	50	209	146	83	58
AUTO ORBITER	6	70	75	27	3
AUTO SURF. VEHICLE	36	165	247	183	108
SATURN V PROCUREMENT		10	144	168	354
CSM PROCUREMENT		17	84	98	98
LM PROCUREMENT		140	140	140	140
PLANETARY EXPLORATION	48	129	222	269	352
SRT	22	27	30	33	32
73 MARS EXPLORER		5	17	8	3
75 MARS EXPLORER				5	17
75 MARS ROUGH LANDER		3	15	34	54
77 MARS SOFT LANDER				18	42
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
73 VENUS FLYBY (PROBES)	20	52	69	34	3
75 VENUS ORBITER				4	13
75 VENUS FLYBY			5	21	69
76 VENUS ORBITER				2	10
74 JUPITER FLYBY		15	32	56	31
77/78 GRAND TOUR					8
76 D'ARREST				10	32
73 MERCURY/VENUS	3	14	29	22	12
75 MERCURY/VENUS			8	12	20
ASTRONOMY	27	62	78	96	87
SOUNDING ROCKETS, SRT	5	10	10	12	16
OSO (I-K)	3	8	14	21	15
OAO (D-E)	15	33	30	30	18
EXPLORERS	2	9	22	30	35
AIRPLANE OBSERVATORY	2	2	2	3	3

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS	19	35	66	75	79
EARTH ENVIRONMENT	10	20	27	31	36
INTERPLANETARY	2	4	5	10	10
SPACE LAB	3	7	13	12	11
LAUNCH VEHICLES	4	4	21	24	22
SPACE BIOLOGY	5	14	41	51	42
BIOSATELLITES (G-H)	1	4	15	16	8
IMPROVED BIOSATELLITES (A-F)	1	1	6	13	21
BIOPIONEER (A-B)	1	3	6	9	7
BIO-EXPLORER (A-B)	1	4	6	6	
SRT/ADV STUDIES	1	2	3	4	5
AIRCRAFT TECHNOLOGY	27	46	76	96	111
ADVANCED SPACE TECHNOLOGY	77	154	181	220	191
SPACE POWER & ELEC PROP	11	22	27	27	19
NUCLEAR PROPULSION	21	42	42	39	35
CHEMICAL PROPULSION	18	27	26	31	22
SPACE VEHICLES	3	8	12	14	11
ELECTRONIC SYSTEMS	13	29	38	64	57
HUMAN FACTORS	7	18	29	31	32
BASIC RESEARCH	2	4	5	5	6
LAUNCH VEHICLES	2	4	2	10	8
SPACE APPLICATIONS	72	106	170	219	233
SRT/AAFE	21	21	19	7	7
SYN MET	9	8	1		
ERS A/C	4	4	4	4	4
ERTS (A-B)	10	13	9	9	5
ERTS LIM, OBJ, (A-B)	6	4	1		
ATS (H-J)	10	20	26	33	29
TDRSS	5	12	28	50	46
GEOS (C-D)	5	8	5	3	3
WWW	2	8	36	29	8
TIROS		5	11	9	2
DIRECT TV		3	10	26	40
LOW ALT. EQ			1	4	24
NIMBUS (G & H)			1	4	25
ATS MET			10	7	5
ERS LIM. OBJ. (C&D)			2	3	4
ERS ISE			2	11	11
NAV/TR CONTROL			3	19	20
SUPPORTING ACTIVITIES	17	19	33	10	10
TRACKING AND DATA ACQUISITION	17	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-7

FUNDING REQUIREMENTS ABOVE BASELINE

(IN MILLIONS OF DOLLARS)

$4.1 BILLION/YEAR LEVEL - "CONQUEST" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON	195	370	745	745	715
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
SUPPORTING DEVELOPMENT	45	45	45	45	45
AAP	150	150			
EMSF	38	166	563	905	947
SATURN IB		13	67	110	110
EXPERIMENTS	10	91	145	168	136
PROGRAM DEFINITION	28				
INT 21		13	85	109	49
MISSION OPERATIONS				6	76
LAB. AND EXP. MOD.		45	102	159	276
NEW LOGISTIC S/C		4	164	353	300
LUNAR EXPLORATION	9	111	449	633	731
BASIC SCIENCE/PROJ. DEF	6	15	15	15	43
PHASE C	3	4	3	2	
EXTENDED APOLLO		92	220	117	70
AUTO ORBITER			44	131	212
SATURN V PROCUREMENT			10	144	168
CSM PROCUREMENT			17	84	98
LM PROCUREMENT			140	140	140
PLANETARY EXPLORATION	70	158	252	287	355
SRT, DATA ANALYSIS	39	48	51	55	55
73 MARS MARINER ORBITER		13	27	22	5
75 MARS EXPLORER				5	17
75 MARS ORBITER/LANDER		18	52	89	128
77 MARS ORBITER/LANDER				25	41
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
73 VENUS FLYBY (PROBES)	20	52	69	34	3
75 VENUS EXPLORER				4	13
73 MERCURY/VENUS SWINGBY	3	14	29	22	12
75 MERCURY/VENUS SWINGBY			6	11	30
77-78 GRAND TOUR					15
76 COMET D'ARREST			8	10	32
ASTRONOMY	27	72	102	121	123
SOUNDING ROCKETS, SRT	5	10	10	12	16
OSO (I-K)	3	8	14	21	15
OAO (D-E)	15	33	30	30	18
EXPLORERS	2	9	28	30	35
ASTRA		10	17	25	35
AIRPLANE OBSERVATORY	2	2	2	2	2

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS	12	21	31	35	38
EARTH ENVIRONMENT	7	13	14	18	19
INTERPLANETARY	2	4	4	4	5
SPACE LAB			3	5	9
LAUNCH VEHICLES	3	4	10	8	5
BIOLOGY	2	8	26	34	26
BIOSATELLITES (G-I)	1	5	20	24	19
BIO PIONEER (A-B)	1	3	6	9	7
AIRCRAFT TECHNOLOGY	27	46	76	96	111
ADVANCED SPACE TECHNOLOGY	77	154	181	220	191
SPACE POWER & ELEC PROP	11	22	27	27	19
NUCLEAR PROPULSION	21	42	42	39	35
CHEMICAL PROPULSION	18	27	26	31	22
SPACE VEHICLES	3	8	12	14	11
ELECTRONIC SYSTEMS	13	29	38	64	57
HUMAN FACTORS	7	18	29	31	32
BASIC RESEARCH	2	4	5	5	6
LAUNCH VEHICLES	2	4	2	10	8
SPACE APPLICATIONS	5	47	98	120	121
SRT/AAFE	1	10	11	5	5
NIMBUS (A-F)		-4	-4	4	5
SYN MET		9	8	1	
WWW		5	20	14	2
LOW ALT EQ			1	4	19
ERS A/C		3	3	3	3
ERTS (A-B)		2	13	13	9
ERS LIM. OBJ. (A-B)		6	4	1	
ERS LIM. OBJ. (C-D)			2	3	4
ATS (H-J)			10	20	26
GEOS C	4	4	2	2	2
TDRSS		12	28	50	46
SUPPORTING ACTIVITIES	17	19	33	10	10
TRACKING AND DATA ACQUISITION	17	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-8
FUNDING REQUIREMENTS ABOVE BASELINE
(IN MILLIONS OF DOLLARS)
$4.1 BILLION/YEAR LEVEL - "RETURNS" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON		175	700	700	675
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
EMSF	38	234	474	702	801
SATURN IB		124	150	103	96
LAB		2	89	222	203
QCM & LOG MOM			53	185	270
EXPERIMENTS	10	108	182	184	138
PROGRAM DEFINITION	28				
MISSION OPERATIONS				8	94
LUNAR EXPLORATION	111	626	851	742	804
BASIC SCIENCE/PROJ. DEF.	15	15	15	43	43
PHASE C	8				
EXTENDED APOLLO	50	209	146	83	58
AUTO ORBITER	6	70	75	27	3
AUTO SURF. VEHICLE	36	165	247	183	108
SATURN V PROCUREMENT		10	144	168	254
CSM PROCUREMENT		17	84	98	98
LM PROCUREMENT		140	140	140	140
PLANETARY EXPLORATION	28	77	168	266	354
SRT	22	27	30	33	32
73 MARS EXPLORER		5	17	8	3
75 MARS EXPLORER				5	17
75 MARS ROUGH LANDER		3	15	34	54
77 MARS SOFT LANDER				18	42
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
73 VENUS FLYBY (PROBES)			20	52	69
75 VENUS ORBITER				4	13
75 VENUS FLYBY					5
76 VENUS ORBITER				2	10
74 JUPITER FLYBY		15	32	56	31
77/78 GRAND TOUR					8
76 D'ARREST				10	32
73 MERCURY/VENUS	3	14	29	22	12
75 MERCURY/VENUS			8	12	20
ASTRONOMY	27	62	78	96	87
SOUNDING ROCKETS, SRT	5	10	10	12	16
OSO (I-K)	3	8	14	21	15
OAO (D-E)	15	33	30	30	18
EXPLORERS	2	9	22	30	35
AIRPLANE OBSERVATORY	2	2	2	3	3

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS	19	35	66	75	79
EARTH ENVIRONMENT	10	20	27	31	36
INTERPLANETARY	2	4	5	10	10
SPACE LAB	3	7	13	12	11
LAUNCH VEHICLES	4	4	21	24	22
SPACE BIOLOGY	5	14	41	51	42
BIOSATELLITES (G-H)	1	4	15	16	8
IMPROVED BIOSATELLITES (A-F)	1	1	6	13	21
BIOPIONEER (A-B)	1	3	6	9	7
BIO-EXPLORER (A-B)	1	4	6	6	
SRT/ADV STUDIES	1	2	3	4	5
AIRCRAFT TECHNOLOGY	31	80	146	170	182
ADVANCED SPACE TECHNOLOGY	77	154	181	220	191
SPACE POWER & ELEC PROP	11	22	27	27	19
NUCLEAR PROPULSION	21	42	42	39	35
CHEMICAL PROPULSION	18	27	26	31	22
SPACE VEHICLES	3	8	12	14	11
ELECTRONIC SYSTEMS	13	29	38	64	57
HUMAN FACTORS	7	18	29	31	32
BASIC RESEARCH	2	4	5	5	6
LAUNCH VEHICLES	2	4	2	10	8
SPACE APPLICATIONS	107	183	300	357	331
SRT/AAFE	40	37	37	9	9
SYN MET	9	8	1		
ERS A/C	6	6	6	6	6
ERTS (A-B)	9	22	21	2	1
ERS LIM. OBJ. (A-B)	6	4	1		
ATS (H-J)	15	26	43	39	17
TDRSS	5	14	29	53	49
DIST TV	2	10	16	40	29
NAV/TR CONTROL	6	21	20	7	2
GEOS (C-D)	5	8	5	3	3
WWW	2	11	46	47	15
TIROS FOLLOW-ON	1	6	13	9	2
NIMBUS (G-H)		1	4	25	35
ATS MET		2	4	11	13
ERS ISE		2	11	11	6
ERS LIM. OBJ. (C-D)		2	8	5	1
DIRECT TV		5	20	31	47
LOW ALT EQ			5	24	30
ATS (K-M)			5	15	31
ERTS MULT. SENSOR			5	21	33
SUPPORTING ACTIVITIES	17	19	33	10	10
TRACKING AND DATA ACQUISITION	17	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-9
FUNDING REQUIREMENTS ABOVE BASELINE
(IN MILLIONS OF DOLLARS)
$3.5 BILLION/YEAR LEVEL - "BALANCED" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON	-90	105	670	700	675
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
CANCEL ATM AND SA 213/214	-90	-45	-30		
EMSF	38	153	478	796	898
SATURN IB		13	67	110	110
EXPERIMENTS	10	91	145	168	136
PROGRAM DEFINITION	28				
MISSION OPERATIONS				6	76
LAB. AND EXP. MOD.		45	102	159	276
NEW LOGISTIC S/C "		4	164	353	300
LUNAR EXPLORATION	5	115	238	134	113
BASIC SCIENCE/PROJ. DEF.	2	19	15	15	43
PHASE C	3	4	3	2	
EXTENDED APOLLO		92	220	117	70
PLANETARY EXPLORATION	11	50	100	119	161
SRT		19	20	18	14
73 MARS EXPLORER		5	17	8	3
75 MARS EXPLORER				5	17
77 MARS ROUGH LANDER				3	15
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
75 VENUS FLYBY			17	42	54
73 MERCURY/VENUS SWINGBY	3	14	29	22	12
77 - 78 GRAND TOUR					9
76 COMET D'ARREST				10	32
ASTRONOMY	5	34	61	72	84
SOUNDING ROCKETS, SRT		5	5	5	5
OSO (I-K)	1	3	8	11	16
OAO (D-E)		15	24	23	25
EXPLORERS	2	9	22	30	35
AIRPLANE OBSERVATORY	2	2	2	3	3

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS		12	21	31	35
EARTH ENVIRONMENT		7	13	14	18
INTERPLANETARY		2	4	4	4
SPACE LAB				3	5
LAUNCH VEHICLES		3	4	10	8
SPACE BIOLOGY	-16	-16	-17	-8	
CANCEL '71/72 BIOSATELLITE	-16	-16	-17	-8	
AIRCRAFT TECHNOLOGY		46	76	96	111
ADVANCED SPACE TECHNOLOGY		100	100	100	100
SPACE POWER & ELEC PROP	4	22	22	22	22
NUCLEAR PROPULSION	-15	-10	-10	-10	-10
CHEMICAL PROPULSION	4	28	28	28	28
SPACE VEHICLES		8	8	8	8
ELECTRONIC SYSTEMS	4	29	29	29	29
HUMAN FACTORS	3	18	18	18	18
BASIC RESEARCH		2	2	2	2
LAUNCH VEHICLES		3	3	3	3
SPACE APPLICATIONS	5	35	70	70	75
SRT/AAFE	1	10	11	5	5
NIMBUS (A-F)		-4	-4	4	5
SYN MET		9	8	1	
WWW		5	20	14	2
LOW ALT EQ			1	4	19
ERS A/C		3	3	3	3
ERTS (A-B)		2	13	13	9
ERS LIM. OBJ. (A-B)		6	4	1	
ERS LIM. OBJ. (C-D)			2	3	4
ATS (H-J)			10	20	26
GEOS C	4	4	2	2	2
SUPPORTING ACTIVITIES	17	19	33	10	10
TRACKING AND DATA ACQUISITION	17	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-10

FUNDING REQUIREMENTS ABOVE BASELINE

(IN MILLIONS OF DOLLARS)

$3.5 BILLION/YEAR LEVEL - "CONQUEST" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON	-90	105	670	700	675
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
CANCEL ATM AND SA213/214	-90	-45	-30		
EMSF	38	153	478	796	898
SATURN IB		13	67	110	110
EXPERIMENTS	10	91	145	168	136
PROGRAM DEFINITION	28				
MISSION OPERATIONS				6	76
LAB. AND EXP. MOD.		45	102	159	276
NEW LOGISTIC S/C		4	164	353	300
LUNAR EXPLORATION	5	115	238	134	113
BASIC SCIENCE/PROJ. DEF."	2	19	15	15	43
PHASE C	3	4	3	2	
EXTENDED APOLLO		92	220	117	70
PLANETARY EXPLORATION	11	64	113	117	129
SRT		18	20	18	16
73 MARS EXPLORER		5	17	8	3
73 MARS ORBITER		15	30	25	5
75 MARS EXPLORER				5	17
77 MARS SOFT LANDER				25	59
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
75 VENUS EXPLORER				4	13
73 MERCURY/VENUS SWINGBY	3	14	29	22	12
ASTRONOMY	5	34	61	72	84
SOUNDING ROCKETS, SRT		5	5	5	5
OSO (I-K)	1	3	8	11	16
OAO (D-E)		15	24	23	25
EXPLORERS	2	9	22	30	35
AIRPLANE OBSERVATORY	2	2	2	3	3

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS	-4	6	17	30	35
EARTH ENVIRONMENT		7	13	14	18
INTERPLANETARY		2	4	4	4
SPACE LAB				3	5
LAUNCH VEHICLES		3	4	10	8
CANCEL SUNBLAZER	-4	-6	-4	-1	
SPACE BIOLOGY	-16	-16	-17	-8	
CANCEL 71/72 BIOSATELLITE	-16	-16	-17	-8	
AIRCRAFT TECHNOLOGY		46	76	96	111
ADVANCED SPACE TECHNOLOGY		100	100	100	100
SPACE POWER & ELEC. PROP.	4	22	22	22	22
NUCLEAR PROPULSION	-15	-10	-10	-10	-10
CHEMICAL PROPULSION	4	28	28	28	28
SPACE VEHICLES		8	8	8	8
ELECTRONIC SYSTEMS	4	29	29	29	29
HUMAN FACTORS	3	18	18	18	18
BASIC RESEARCH		2	2	2	2
LAUNCH VEHICLES		3	3	3	3
SPACE APPLICATIONS	1	35	72	70	75
SRT/AAFE		10	11	5	5
NIMBUS (A-F)		-4	-4	4	5
SYN MET		9	8	1	
WWW		5	20	14	2
LOW ALT EQ			1	4	19
ERS A/C		3	3	3	3
ERTS (A-B)		2	13	13	9
ERS LIM OBJ. (A-B)		6	4	1	
ERS LIM. OBJ. (C-D)			2	3	4
ATS (H-J)			10	20	26
GEOS C		4	4	2	2
SUPPORTING ACTIVITIES	14	19	33	10	10
TRACKING AND DATA ACQUISITION	14	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-11
FUNDING REQUIREMENTS ABOVE BASELINE
(IN MILLIONS OF DOLLARS)
$3.5 BILLION LEVEL/YEAR "RETURNS" PROGRAM

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
OMSF COMMON	-180	150	700	700	675
KSC/MSC OPERATION		70	400	400	400
SATURN IB CAPABILITY		50	50	25	
SATURN V CAPABILITY		10	140	165	165
SPACECRAFT CAPABILITY		45	110	110	110
DEFER AS 514/515	-180	-25			
EMSF	38	234	474	702	801
SATURN IB		124	150	103	96
LAB		2	89	222	203
QCM AND LOG MOM			53	185	270
EXPERIMENTS	10	108	182	184	138
MISSION OPERATIONS				8	94
PROGRAM DEFINITION	28				
LUNAR EXPLORATION	5	115	238	134	113
BASIC SCIENCE/PROJ. DEF.	2	19	15	15	43
PHASE C	3	4	3	2	
EXTENDED APOLLO		92	220	117	70
PLANETARY EXPLORATION	22	50	100	119	161
SRT	11	19	20	18	14
73 MARS EXPLORER		5	17	8	3
75 MARS EXPLORER				5	17
77 MARS ROUGH LANDER				3	15
72 VENUS EXPLORER	8	9	7	2	
73 VENUS EXPLORER		3	10	8	4
75 VENUS FLYBY			17	42	54
73 MERCURY/VENUS SWINGBY	3	14	29	22	12
77 - 78 GRAND TOUR					9
76 COMET D'ARREST				10	32
ASTRONOMY	5	34	61	72	84
SOUNDING ROCKETS, SRT		5	5	5	5
OSO (I-K)	1	3	8	11	16
OAO (D-E)		15	24	23	25
EXPLORERS	2	9	22	30	35
AIRPLANE OBSERVATORY	2	2	2	3	3

PROGRAM CATEGORY/PROJECT	FY70	71	72	73	74
SPACE PHYSICS		12	21	31	35
EARTH ENVIRONMENT		7	13	14	18
INTERPLANETARY		2	4	4	4
SPACE LAB				3	5
LAUNCH VEHICLES		3	4	10	8
BIOLOGY	2	8	26	34	26
BIOSATELLITES (G-I)	1	5	20	24	19
BIO PIONEER (A-B)	1	3	6	9	7
AIRCRAFT TECHNOLOGY		46	76	96	111
ADVANCED SPACE TECHNOLOGY		100	100	100	100
SPACE POWER & ELEC PROP	4	22	22	22	22
NUCLEAR PROPULSION	-15	-10	-10	-10	-10
CHEMICAL PROPULSION	4	28	28	28	28
SPACE VEHICLES		8	8	8	8
ELECTRONIC SYSTEMS	4	29	29	29	29
HUMAN FACTORS	3	18	18	18	18
BASIC RESEARCH		2	2	2	2
LAUNCH VEHICLES		3	3	3	3
SPACE APPLICATIONS	24	63	105	120	123
SRT/AAFE	9	7	11	5	5
NIMBUS (A-F)		-4	-4	4	5
SYN MET		9	8	1	
WWW		5	20	14	2
LOW ALT EQ			1	4	19
ERS A/C	3	3	3	3	3
ERTS (A-B)	2	13	13	9	6
ERS LIM. OBJ. (A-B)	6	4	1		
ERS. LIM. OBJ. (C-D)			2	3	3
ATS (H-J)		10	20	26	32
GEOS C	4	4	2	2	2
TDRSS		12	28	50	46
SUPPORTING ACTIVITIES	17	19	33	10	10
TRACKING AND DATA ACQUISITION	17	9	23		
LAUNCH VEHICLES		10	10	10	10

TABLE 5-12

SUMMARY OF FUNDING REQUIREMENTS

VARIATION FROM BASELINE (IN MILLIONS OF DOLLARS)

$4.1 BILLION/YEAR LEVEL

	CONQUEST					BALANCED					RETURNS				
	FY70	71	72	73	74	FY70	71	72	73	74	FY70	71	72	73	74
OMSF COMMON	195	370	745	745	715		175	700	700	675		175	700	700	675
EMSF	38	166	563	905	947	38	166	563	905	947	38	234	474	702	801
LUNAR EXPLORATION	9	111	449	633	731	111	626	851	742	804	111	626	851	742	804
PLANETARY EXPLORATION	70	158	252	287	355	48	129	222	269	352	28	77	168	266	354
ASTRONOMY	27	72	102	121	123	27	62	78	96	87	27	62	78	96	87
SPACE PHYSICS	12	21	31	35	38	19	35	66	75	79	19	35	66	75	79
SPACE BIOLOGY	2	8	26	34	26	5	14	41	51	42	5	14	41	51	42
AIRCRAFT TECH.	27	46	76	96	111	27	46	76	96	111	31	80	146	170	182
ADV. SP. TECH.	77	154	181	220	191	77	154	181	220	191	77	154	181	220	191
SPACE APPLICATIONS	5	47	98	120	121	72	106	170	219	233	107	183	300	357	331
SUPPORTING ACTIVITIES	17	19	33	10	10	17	19	33	10	10	17	19	33	10	10
BASELINE	3681	2735	1833	1619	1473	3681	2735	1833	1619	1473	3681	2735	1833	1619	1473
PROGRAM TOTAL	4160	3907	4389	4825	4841	4122	4267	4814	5002	5004	4141	4394	4871	5008	5029

$3.8 BILLION/YEAR LEVEL

	CONQUEST					BALANCED					RETURNS				
	FY70	71	72	73	74	FY70	71	72	73	74	FY70	71	72	73	74
OMSF COMMON		175	700	700	675		175	700	700	675		175	700	700	675
EMSF	38	166	563	905	947	38	166	563	905	947	38	234	474	702	801
LUNAR EXPLORATION	9	111	449	633	731	9	115	626	851	742	9	115	459	483	336
PLANETARY EXPLORATION	50	138	231	267	335	22	50	100	119	161	22	50	100	119	161
ASTRONOMY	5	34	61	72	84	5	34	61	72	84	5	34	61	72	84
SPACE PHYSICS		12	21	31	35	12	21	31	35	38	12	21	31	35	38
SPACE BIOLOGY						2	8	26	34	26	2	8	26	34	26
AIRCRAFT TECH.	27	46	76	96	111	27	46	76	96	111	27	46	76	96	111
ADV. SP. TECH.	18	110	110	110	110	18	110	110	110	110	18	110	110	110	110
SPACE APPLICATIONS	5	35	70	70	75	5	35	70	70	75	52	90	148	185	196
SUPPORTING ACTIVITIES	17	19	35	10	10	17	19	33	10	10	17	19	33	10	10
BASELINE	3681	2735	1833	1619	1473	3681	2735	1833	1619	1473	3681	2735	1833	1619	1473
PROGRAM TOTAL	3850	3581	4139	4513	4586	3836	3514	4229	4621	4452	3883	3637	4051	4165	4021

$3.5 BILLION/YEAR LEVEL

	CONQUEST					BALANCED					RETURNS				
	FY70	71	72	73	74	FY70	71	72	73	74	FY70	71	72	73	74
OMSF COMMON	-90	105	670	700	675	-90	105	670	700	675	-180	150	700	700	675
EMSF	38	153	478	796	898	38	153	478	796	898	38	234	474	702	801
LUNAR EXPLORATION	5	115	238	134	113	5	115	238	134	113	5	115	238	134	113
PLANETARY EXPLORATION	11	64	113	117	129	11	50	100	119	161	22	50	100	119	161
ASTRONOMY	5	34	61	72	84	5	34	61	72	84	5	34	61	72	84
SPACE PHYSICS	-4	6	17	30	35		12	21	31	35		12	21	31	35
SPACE BIOLOGY	-16	-16	-17	-8		-16	-16	-17	-8		2	8	26	34	26
AIRCRAFT TECH.		46	76	96	111		46	76	96	111		46	76	96	111
ADV. SP. TECH.		100	100	100	100		100	100	100	100		100	100	100	100
SPACE APPLICATIONS	1	35	72	70	75	5	35	70	70	75	24	63	105	120	123
SUPPORTING ACTIVITIES	14	19	33	10	10	17	19	33	10	10	17	19	33	10	10
BASELINE	3681	2735	1833	1619	1473	3681	2735	1833	1619	1473	3681	2735	1833	1619	1473
PROGRAM TOTAL	3645*	3396	3674	3736	3703	3656*	3388	3663	3739	3735	3614*	3566	3767	3737	3712

*59M CARRYOVER FROM '69; 3586 NOA REQUIRED.

*58M CARRYOVER FROM '69; 3598 NOA REQUIRED.

*70M CARRYOVER FROM '69; 3544 NOA REQUIRED.

TABLE 5-13

SUMMARY OF FUNDING REQUIREMENTS

PROGRAM CATEGORY TOTAL COSTS (IN MILLIONS OF DOLLARS)

4.1 BILLION LEVEL

	CONQUEST					BALANCED					RETURNS				
	FY70	71	72	73	74	FY70	71	72	73	74	FY70	71	72	73	74
OMSF COMMON	2121	1427	937	820	725	1926	1232	892	775	685	1926	1232	892	775	685
EMSF	38	166	563	905	947	38	166	563	905	947	38	234	474	702	801
LUNAR EXPLORATION	14	116	454	638	736	116	631	856	747	809	116	631	856	747	809
PLANETARY EXPLORATION	192	292	403	386	399	170	263	373	368	396	150	211	319	365	398
ASTRONOMY	102	110	127	142	142	102	100	103	117	106	102	100	103	117	106
SPACE PHYSICS	74	67	67	62	63	81	81	102	102	104	81	81	102	102	104
SPACE BIOLOGY	42	47	50	49	33	45	54	65	65	49	45	54	65	65	49
AIRCRAFT TECH	125	140	152	166	181	125	140	152	166	181	129	174	223	241	252
ADV. SP. TECH.	235	304	331	370	341	235	304	331	370	341	235	304	331	370	341
SPACE APPLICATIONS	128	156	193	185	168	195	215	265	284	280	230	292	395	422	378
SUPPORTING ACTIVITIES	1090	1082	1113	1102	1107	1090	1082	1113	1102	1107	1090	1082	1113	1102	1107
TOTAL	4160	3907	4389	4825	4841	4122	4267	4814	5002	5004	4141	4394	4871	5008	5029

3.8 BILLION LEVEL

OMSF COMMON	1926	1232	892	775	685	1926	1232	892	775	685	1926	1232	892	775	685
EMSF	38	166	563	905	947	38	166	563	905	947	38	234	474	702	801
LUNAR EXPLORATION	14	116	454	638	736	14	120	631	856	747	14	120	464	488	341
PLANETARY EXPLORATION	172	272	382	366	379	144	184	251	218	205	144	184	251	218	205
ASTRONOMY	80	72	86	93	103	80	72	86	93	103	80	72	86	93	103
SPACE PHYSICS	62	58	57	58	60	74	67	67	62	63	74	67	67	62	63
SPACE BIOLOGY	40	39	24	15	7	42	47	50	49	33	42	47	50	49	33
AIRCRAFT TECH.	125	140	152	166	181	125	140	152	166	181	125	140	152	166	181
ADV. SP. TECH.	176	260	260	260	260	176	260	260	260	260	176	260	260	260	260
SPACE APPLICATIONS	128	144	165	135	122	128	144	165	135	122	175	199	243	250	243
SUPPORTING ACTIVITIES	1090	1082	1113	1102	1107	1090	1082	1113	1102	1107	1090	1082	1113	1102	1107
TOTAL	3850	3581	4139	4513	4586	3836	3514	4229	4621	4452	3883	3637	4051	4165	4021

3.5 BILLION LEVEL

OMSF COMMON	1836	1162	862	775	685	1836	1162	862	775	685	1746	1207	892	775	685
EMSF	38	153	478	796	898	38	153	478	796	898	38	234	474	702	801
LUNAR EXPLORATION	10	120	243	139	118	10	120	243	139	118	10	120	243	139	118
PLANETARY EXPLORATION	133	198	264	216	173	133	184	251	218	205	144	184	251	218	205
ASTRONOMY	80	72	86	93	103	80	72	86	93	103	80	72	86	93	103
SPACE PHYSICS	58	52	53	57	60	62	58	57	58	60	62	58	57	58	60
SPACE BIOLOGY	24	23	7	7	7	24	23	7	7	7	42	47	50	49	33
AIRCRAFT TECH.	98	140	152	166	181	98	140	152	166	181	98	140	152	166	181
ADV. SP. TECH.	158	250	250	250	250	158	250	250	250	250	158	250	250	250	250
SPACE APPLICATIONS	124	144	167	135	122	128	144	165	135	122	147	172	200	185	170
SUPPORTING ACTIVITIES	1087	1082	1113	1102	1107	1090	1082	1113	1102	1107	1090	1082	1113	1102	1107
TOTAL	*3645	3396	3674	3736	3703	*3656	3388	3663	3739	3735	*3614	3566	3767	3737	3712

*59M CARRYOVER FROM '69; 3586 NOA REQUIRED

*58M CARRYOVER FROM '69; 3598 NOA REQUIRED

*70M CARRYOVER FROM '69; 3544 NOA REQUIRED

Tables 5-14/5-16
Launch Schedules

TABLE 5-14
PLANNING LAUNCH SCHEDULE - $3.8 BILLION/YEAR LEVEL

	CONQUEST						BALANCED						RETURNS OF SPACE ACTIVITY						LAUNCH VEHICLE
	CY 69	70	71	72	73	74	CY 69	70	71	72	73	74	CY 69	70	71	72	73	74	
OMSF COMMON																			
APOLLO	1						1						1						SATURN V
AAP		2	3					2	3					2	3				SATURN IB
POST APOLLO		1	1					2	1					2	1				SATURN V
EMSF																			
EOSL																		2	INT 21
LOG. VEHICLE						2						2						3	TITAN III M
LUNAR EXPLORATION																			
EXT. APOLLO					1	2					1	1					1	1	SATURN V
ADV. ORBITER											1	3					1	3	TITAN III/CENTAUR
ADV. LUNAR SURF. VEHICLE												2						2	TITAN III/CENTAUR
PLANETARY EXPLORATION																			
MARS-MARINER F/B	2						2						2						ATLAS/CENTAUR
MARS-MARINER ORB.			2		1				2						2				ATLAS/CENTAUR OR TITAN III C
MARS-EXPLORER ORB.											1						1		ATLAS/BURNER II
MARS-LANDERS					2						2						2		ATLAS/CENTAUR OR TITAN III C
VENUS-EXPLORER ORB.				1	1					1	1					1	1		ATLAS/BURNER II
VENUS-MARINER F/B (PROBES)					2														ATLAS/CENTAUR
MERCURY/VENUS S/B					1						1						1		ATLAS/CENTAUR
JUPITER-PIONEER F/B				1	1					1	1					1	1		ATLAS/CENTAUR/TE-364
ASTRONOMY																			
OAO (B-E)	1	1			1	1	1	1			1	1	1	1			1	1	ATLAS/CENTAUR
OSO (G-J)	1	1			1	1	1	1			1	1	1	1			1	1	THOR/DELTA
EXPLORERS	1	1	1	2	3	4	1	1	1	2	3	4	1	1	1	2	3	4	THOR/DELTA SCOUT
SPACE PHYSICS																			
IMP	1	1	1	1			1	1	1	1			1	1	1	1			DELTA
OGO	1						1						1						ATLAS/AGENA
ISIS	1	1	1				1	1	1				1	1	1				DELTA
UNIVERSITY	2						2						2						SCOUT
COOPERATIVES	1	3					1	3					1	3					SCOUT
SUNBLAZER		1	2	2				1	2	2				1	2	2			SCOUT
IMP FOLLOW-ON												1						1	DELTA
ATMOSPHERE EXPLORER					1	1				1	1					1	1		DELTA
CLUSTER																			DELTA
SMALL SCI. SAT.		1	1		1			1	1	1		1		1	1	1		1	SCOUT
METEOROID																			SCOUT
SOLAR PROBE						1					1	1					1	1	ATLAS/CENTAUR/TE-364
PIONEER F&G				1	1					1	1					1	1		THORAD
SPACE BIOLOGY																			
BIOSATELLITE (C-F)	1	1	1	1			1	1	1	1			1	1	1	1			THOR/DELTA
BIOSATELLITE (F/O)											1	1					1	1	
BIOPIONEER											1	1					1	1	
BIOEXPLORER																			SCOUT
ADVANCED SPACE TECHNOLOGY																			
SERT II	1						1						1						THORAD/AGENA
METEOROID PROTECTION		1						1						1					SCOUT
REENTRY	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1		SCOUT
OTOLITH	1		1				1		1	1			1		1	1			SCOUT
ADV. PROJECTS					2	2					2	2					2	2	
SPACE APPLICATIONS																			
TIROS/TOS IMP	1						1						1				1		THOR/DELTA
NIMBUS (C-F)	1	1		1	1		1	1		1	1		1	1		1	1		ATLAS/AGENA
ATS (MET)																		1	TAT/DELTA
SYNCH (MET)				1						1					1				DELTA/TE-364
WWW					1						1						2		TAT/AGENA
ATS (E-G)	1			1	1		1			1	1		1			1	1		ATLAS/CENTAUR
GEOS		1						1						1		1			THOR/DELTA
ERTS					1						1				1		1		
ERS/LOW				1	1	1				1	1	1			1	1	1	1	
TDRSS																		1	ATLAS/CENTAUR
MET. EXPERIMENTS																			TAT/DELTA
LOW ALT. EQUATORIAL																			TAT/DELTA

TABLE 5-15
PLANNING LAUNCH SCHEDULE - $4.1 BILLION/YEAR LEVEL

	CONQUEST OF SPACE						BALANCED						RETURNS OF SPACE ACTIVITY						LAUNCH VEHICLE
	CY 69	70	71	72	73	74	CY 69	70	71	72	73	74	CY 69	70	71	72	73	74	
OMSF COMMON																			
APOLLO	1						1						1						SATURN V
AAP		2	3					2	3					2	3				SATURN IB
POST APOLLO		1	1					2	1					2	1				SATURN V
EMSF																			
EOSL																		2	INT 21
LOG. VEHICLE						2						2						3	TITAN III M
LUNAR EXPLORATION																			
EXT. APOLLO					1	2				1	1	2				1	1	2	SATURN V
ADV. ORBITER										1	3					1	3		TITAN III/CENTAUR
ADV. LUNAR SURF. VEHICLE											2	2					2	2	TITAN III/CENTAUR
PLANETARY EXPLORATION																			
MARS-MARINER F/B	2						2						2						ATLAS/CENTAUR
MARS-MARINER ORB.			2		1				2						2				ATLAS/CENTAUR OR TITAN III C
MARS-EXPLORER ORB.											1						1		ATLAS/BURNER II
MARS-LANDERS					2						2						2		ATLAS/CENTAUR OR TITAN III C
VENUS-EXPLORER ORB.				1	1					1	1					1	1		ATLAS/BURNER II
VENUS-MARINER F/B (PROBES)					2						2								ATLAS/CENTAUR
MERCURY/VENUS S/B					1						1						1		ATLAS/CENTAUR
JUPITER-PIONEER F/B				1	1					1	1					1	1		ATLAS/CENTAUR/TE-364
JUPITER-ADV. PROBE F/B												1						1	TITAN IIID/CENTAUR/BURNER II
ASTRONOMY																			
OAO (B-E)	1	1		1		1	1	1		1	1		1	1		1	1		ATLAS/CENTAUR
OSO (G-J)	1	1		1	1		1	1		1	1		1	1		1	1		THOR/DELTA
EXPLORERS	1	1	1	3	3	4	1	1	1	2	3	4	1	1	1	2	3	4	THOR/DELTA SCOUT
SPACE PHYSICS																			
IMP	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	DELTA
OGO	1						1						1						ATLAS/AGENA
ISIS	1	1	1				1	1	1				1	1	1				DELTA
UNIVERSITY	2						2						2						SCOUT
COOPERATIVES	1	3					1	3					1	3					SCOUT
SUNBLAZER		1	2	2				1	2	2				1	2	2			SCOUT
IMP FOLLOW-ON						1					1	1					1	1	DELTA
ATMOSPHERE EXPLORER				1	1					1	1					1	1		DELTA
CLUSTER												1						1	DELTA
SMALL SCI. SAT.		1	1	1		1		1	1	1	1	1		1	1	1	1	1	SCOUT
METEOROID												1						1	SCOUT
SOLAR PROBE					1	1					1	1					1	1	ATLAS/CENTAUR/ TE-364
PIONEER F&G				1	1					1	1					1	1		THORAD
RELATIVITY											1						1		
SPACE BIOLOGY																			
BIOSATELLITE (C-F)	1	1	1	1			1	1	1	1			1	1	1	1			THOR/DELTA
BIOSATELLITE (F/O)					1	1					1	1					1	1	
BIOPIONEER					1	1					1	1					1	1	
BIOEXPLORER										1	1					1	1		SCOUT
ADVANCED SPACE TECHNOLOGY																			
SERT II	1						1						1						THORAD/AGENA
METEOROID PROTECTION		1						1						1					SCOUT
REENTRY	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1		SCOUT
OTOLITH	1		1				1		1	1			1		1	1			SCOUT
ADV. PROJECTS			1		3	3			1		3	3			1		3	3	
SPACE APPLICATIONS																			
TIROS	1						1				1		1				1		THOR/DELTA
NIMBUS (C-F)	1	1		1	1		1	1		1	1		1	1		1	1	1	ATLAS/AGENA
ATS (MET)												1						2	TAT/DELTA
SYNCH (MET)				1					1						1			1	DELTA/TE-364
WWW					1						2						2	1	TAT/AGENA
ATS (E-G)	1			1	1		1			1	1	1	1			1	1	1	ATLAS/CENTAUR
GEOS		1						1		1				1		1			THOR/DELTA
ERTS					1				1		1				1	1		1	
ERS/LOW				1	1	1			1	1	1	1		1	1	1	1	1	
TDRSS						1						1						1	ATLAS/CENTAUR
LOW ALT. EQUATORIAL																		1	TAT/DELTA
COMMUNITY TV																		1	
AIR TR CONTROL												1				1	1		

TABLE 5-16
PLANNING LAUNCH SCHEDULE - $3.5 BILLION/YEAR LEVEL

	CONQUEST						BALANCED						LAUNCH VEHICLE						RETURNS OF SPACE ACTIVITY
	69	70	71	72	73	74	69	70	71	72	73	74	69	70	71	72	73	74	
OMSF COMMON																			
APOLLO	1						1						1						SATURN V
AAP		2	1					2	3					2	3				SATURN IB
POST APOLLO		1	1					1	1					1	1				SATURN V
EMSF																			
EOSL																		2	INT 21
LOG. VEHICLE						2						2						3	TITAN III M
LUNAR EXPLORATION																			
EXT. APOLLO					1	2					1	2					1	2	SATURN V
ADV. ORBITER																			TITAN III/CENTAUR
ADV. LUNAR SURF. VEHICLE																			TITAN III/CENTAUR
PLANETARY EXPLORATION																			
MARS-MARINER F/B	2						2						2						ATLAS/CENTAUR
MARS-MARINER ORB.			2		1				2						2				ATLAS/CENTAUR OR TITAN III C
MARS-EXPLORER ORB.					1						1						1		ATLAS/BURNER II
MARS-LANDERS					2						2						2		ATLAS/CENTAUR OR TITAN III C
VENUS-EXPLORER ORB.				1	1					1	1					1	1		ATLAS/BURNER II
VENUS-MARINER F/B (PROBES)																			ATLAS/CENTAUR
MERCURY/VENUS S/B					1						1						1		ATLAS/CENTAUR
JUPITER-PIONEER F/B				1	1					1	1					1	1		ATLAS/CENTAUR/TE-364
ASTRONOMY																			
OAO (B-E)	1	1			1	1	1	1			1	1	1	1			1	1	ATLAS/CENTAUR
OSO (G-J)	1	1			1	1	1	1			1	1	1	1			1	1	THOR/DELTA
EXPLORERS	1	1	1	2	3	4	1	1	1	2	3	4	1	1	1	2	3	4	THOR/DELTA SCOUT
SPACE PHYSICS																			
IMP	1	1	1	1			1	1	1	1			1	1	1	1			DELTA
OGO	1						1						1						ATLAS/AGENA
ISIS	1	1	1				1	1	1				1	3	1				DELTA
UNIVERSITY	2						2						2						SCOUT
COOPERATIVES	1	3					1	3					1	3					SCOUT
SUNBLAZER								1	2	2			1	2	2				SCOUT
ATMOSPHERE EXPLORER					1	1					1	1				1	1		DELTA
SMALL SCI. SAT.		1	1		1			1	1		1			1	1		1		SCOUT
METEOROID																			SCOUT
SOLAR PROBE						1						1					1	1	ATLAS/CENTAUR/TE-364
PIONEER					1		1			1	1					1	1		THORAD
SPACE BIOLOGY																			
BIOSATELLITE (C-F)	1	1					1	1	1	1			1	1	1	1			THOR/DELTA
BIOSATELLITE (F/O)																	1	1	
BIOPIONEER																	1	1	
BIOEXPLORER																			SCOUT
ADVANCED SPACE TECHNOLOGY																			
SERT II	1						1						1						THORAD/AGENA
METEOROID PROTECTION		1						1						1					SCOUT
REENTRY	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1		SCOUT
OTOLITH	1		1				1		1	1			1		1	1			SCOUT
ADV. PROJECTS					2	2					2	2					2	2	
SPACE APPLICATIONS																			
TIROS/TOS IMP	1						1						1						THOR/DELTA
NIMBUS (C-F)	1	1		1	1		1	1		1	1		1	1		1	1		ATLAS/AGENA
ATS (MET)																			TAT/DELTA
SYNCH (MET)				1						1							1		DELTA/TE-364
WWW					1						1	1					1		TAT/AGENA
ATS (E-G)	1			1	1		1			1	1		1			1	1		ATLAS/CENTAUR
GEOS			1	1				1							1				THOR/DELTA
ERTS					1						1					1		1	
ERS/LOM				1	1	1				1	1	1			1	1	1	1	
TDRSS																		1	ATLAS/CENTAUR
MET. EXPERIMENTS																			TAT/DELTA
LOW ALT. EQUATORIAL																			TAT/DELTA

Chapter 6
Characterization

Chapter 6

PROGRAM CHARACTERIZATION

6.0 Introduction

This chapter characterizes the Agency program alternatives synthesized in Chapter 5. The intent is to provide the basis for evaluation of the alternatives through display of their comparative properties. To highlight the factors of interest to management, evaluation criteria have been defined in two major categories, Program Accomplishments and Programmatic Factors, which are described in succeeding sections. The applicable data for each program under each of the strategies considered is tabulated.

In developing the material for this chapter, the possibilities of quantifying the characterization data for program evaluation purposes were briefly investigated. A possible approach based on Program Accomplishments is discussed in Appendix II.

6.1 Program Accomplishments

The relative worth of individual programs is reflected in the degree to which they accomplish the Agency's goals.* In order to assess the contribution of a program toward such a goal as "expand our scientific knowledge of space," it is necessary to understand the contributions of individual Program Categories and projects within Categories. To a degree the accomplishments can be determined from the data of Chapter 5. The differences in accomplishments between program alternatives at the project/mission level are more clearly highlighted in Figures 6-1 through 6-3, which cover each Program Category under each of the Agency strategies and funding levels under consideration.** The comparative accomplishments of the program alternatives emphasizing flight projects through CY75, are summarized in Tables 6-1 through 6-3.

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*In general, the worth should be measured against the Agency's objectives, which, as noted in Chapter 4, have not been explicitly defined.

**Aircraft Technology and Supporting Activities are not included since they have been treated generally as level-of-effort programs.

6.2 Programmatic Factors

The significant programmatic factors requiring consideration by management in evaluating a program alternative have been defined and are elaborated upon below.* The characterization of the individual program alternatives in terms of the programmatic factors is summarized in Tables 6-4 through 6-6, each of which is addressed to a particular funding level.

• Funding Pattern. The funding pattern of a program over a five-year period is important in providing a basis not only for determining program feasibility, but also for assessing the completeness of the long-range planning. A decline in funding requirements toward the end of the period would give the impression of dead-ended programs or insufficiency of new starts. An acceptable rise in funding level would reflect more imaginative planning.

• Sensitivity to Budget Cut ($300M/yr). In the current national economic climate it is possible that FY70 budget cuts will be imposed upon some Government agencies. Hence, in proposing the FY70 program, it is desirable to assess its sensitivity to a reduction of about ten per cent from the FY69 level. In general, it would be preferable to arrive at a program which would not require major reorientation in the face of such a reduction. (This factor has not been included in the tables characterizing the programs at the $3.5 and $4.1 billion/year levels.)

• Sensitivity to Budget Increase ($300M/yr). The remarks above are generally applicable here also. In general, a program which could apply and exploit a budgetary increase would be superior to one in which additional funds would require significant reorientation of goals, objectives, strategies, etc.

• Sensitivity to Project/Mission Failures. Within a particular Program Category, it is expected that suitable provision will be made for the evolution from one project to a later one and that back-up redundancy will be provided as appropriate. When, however, the projects of one Category are dependent on the success of projects within another Category, there is a need for further assessment of the sensitivity to failure. One feature of this kind which is common to a number of Categories is the

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*Resource requirements, although clearly of interest to management, are not included in the list of factors. In a climate of heavy resources constraints, the feasibility criterion identified in Section 5.1 should be sufficient in this area. It is assumed that, at each funding level, all program alternatives will take advantage of total resources availability.

development of manned capability to fly experiments supporting the requirements of the science, applications, and technology disciplines.

• Sensitivity to Unanticipated Gain in Knowledge. In general, it is desirable to structure programs so as to permit timely exploitation of new knowledge and so as not to require significant reorientation on gaining new knowledge. Within individual Program Categories the planning can be expected to cover such developments. It is especially important that interfaces between Categories in this area be considered in program evaluation.

• Sensitivity to USSR Achievement. The introduction of up-to-date intelligence estimates of Soviet space activity would permit a more deliberate assessment of the relative merits of the various program alternatives. Consideration should be given not only to the possibility of "firsts" in space demonstration, but also to the potential for accommodating a change in the international environment which would lead to cooperative space projects.

• Maintenance of Scientific, Technical and Administrative Base. Significant program changes, especially those intended to accommodate a reduced level of funding, may lead to weakening of NASA's scientific, technical, and administrative base. Such effects, most of which are of an institutional nature, should be considered in comparing programs

• Continuity of Space Activity. This factor covers the case of a hiatus of space activity within a Program Category as well as gaps in the total program. It is desirable that activity throughout the Agency be generally uniform. At the same time, the pace should not be such that, in preparing for a mission, it is not possible to take advantage of the experience gained from a previous mission.

• Growth Potential. A significant measure of the worth of a program is the degree to which it affords capability or flexibility for carrying out future Agency options. In a sense, this is reflected in the evaluation of program accomplishments, but is is also a factor warranting separate management consideration.

• Major New Starts and Cancellations. Identification of the major new starts for FY70 and FY71 provides indication of (1) the decisions which must be made in the near future, (2) the flexibility available for reshaping the program, (3) the resolution of certain FY70 key issues, and (4) the key issues which may be raised in FY71. For this analysis "new starts" has been defined to include all projects and their associated funding which are not included in the Baseline Program. In addition, necessary cancellations of on-going FY69 programs for the $3.5 billion funding level are delineated.

Figure 6-1
Accomplishments ($3.8B)

Figure 6-1

Program Accomplishments - $3.8 B/yr Funding Level

FIGURE 6-1.1 - EXTENSION OF MANNED SPACE FLIGHT CAPABILITY ($3.8B)

CONQUEST	BALANCED	RETURNS
Same as "Balanced."	The Extension of Manned Space Flight program builds on the experience expected to accrue from AAP missions in 1971 and 1972. The AAP program consists of one 28-day mission and two 56-day missions. The second mission emphasizes medical experiments, the third, solar astronomy using the ATM. An Earth Orbital Space Laboratory will provide a focus for the evolution of long-duration manned space systems in the 1974 to 1978 time frame. A large laboratory will be launched into orbits of 200 n.m. and up to 90° inclination using two-stage versions of the Saturn V. For higher energy orbits, the three-stage Saturn V will be used. The laboratory is an integral nine-man device containing all the essential life support and environmental functions of a space station. A new spacecraft for crew logistics will be developed. This logistics spacecraft will be launched with the Titan IIIM (or possibly the Saturn-IB). After two qualification launches of the new logistic system, the first laboratory launch occurs in late-1974. Crew-logistics launches will occur at 90-day intervals. By mid-1975 the crew complement of this one-year laboratory will reach nine men. A new two-year, nine-man laboratory will be launched in early 1976. Applications experiments will be emphasized in the second mission built around experience acquired in the first mission.	The Extension of Manned Space Flight program builds on the experience expected to accrue from AAP missions in 1971 and 1972. The AAP program consists of one 28-day mission and two 56-day missions. The second mission emphasizes medical experiments, the third, solar astronomy using the ATM. An Earth Orbital Space Laboratory will provide a focus for the evolution of long-duration manned space systems in the 1974 to 1978 time frame. The laboratory will be assembled from small modules launched by the Saturn-IB into orbits of 200 n.m. by 50° inclination. New development activity will be limited to the laboratory and the service module. The service module provides all orbital propulsion, supports the Command Module while in transit, and carries the stabilization and control system for orbital assembly. After flight qualifications of the new hardware, the first mission will be launched in mid-1974. An unmanned launch of a subsystem module will be closely followed by the three astronauts in their crew module. The unmanned experiment module is launched 60 days later, completing the orbital laboratory. Crew logistics launches occur at 90-day intervals thereafter. By not returning the second crew during the third crew rotation launch, the program can provide for six men in orbit by early 1975, and maintain this complement through completion of a one-year mission. A new two-year, six-man laboratory will be launched in mid-1975. Applications experiments will be emphasized in the second mission based on experience acquired in the first mission.

FIGURE 6-1.2 - LUNAR EXPLORATION ($3.8B)

CONQUEST	BALANCED	RETURNS
One Apollo and two Post-Apollo manned landings in 1969-1971. The Apollo mission will include limited geological surveys, sample collection, and photography on the surface and from the Command Module. The two Post-Apollo missions provide landings at features of particular interest, with ALSEP deployment. The astronaut's range is about 1 km by walking on these missions. A two-year gap follows the second Post-Apollo landing in early 1971. Three extended Apollo missions follow, one in late 1973, two in 1974. The extended Apollo missions will provide 3-day staytime on the lunar surface. Improved astronaut mobility (10 km radius) and greater science payload characterizes these missions. During the surface mission, the CSM will conduct photographic and remote sensing experiments and may deploy subsatellites for long-term particle and field measurements. Dual Launches begin in early 1975 and proceed at one-year intervals thereafter.	One Apollo and three Post-Apollo manned landings in 1969-1971. The Apollo missions will include limited geological surveys, sample collection and photography on the surface and from the Command Module. The three Post-Apollo missions provide landings at features of particular interest, with ALSEP deployment. The astronaut's range is about 1 km by walking on these missions. A 30-month gap follows the third Post-Apollo landing in early 1971. In late 1973 a series of four Extended Apollo missions begins: one in 1973, one in 1974, and two in 1975. The Extended Apollo missions provide 3-day staytime on the lunar surface. These missions are supported by automated missions beginning in mid-1973 and extending through late 1975. Four advanced orbiters support the manned landings with high-resolution photography and remote sensing for site selection, science planning, and lunar-wide surveys. Four Automated Surface Vehicle launches deliver Dual Mode Rovers, Remote Geophysical Monitors, and Science Stations to the lunar surface. The Science Station operates at the landing site. The Rover performs a long-range automated traverse, collecting samples and deploying long-lived seismic stations as it progresses. At the end of the traverse, the Rovers are intended to rendezvous with manned landings for sample return. Following the fourth Extended Apollo mission in late-1975, Dual Launch missions begin in early 1976 and proceed at one year intervals thereafter.	Same as Balanced except program terminates after the fourth Extended Apollo mission. No Dual Launch missions in post-1975 period.

FIGURE 6-13 - PLANETARY EXPLORATION ($3.8B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Small Mars/Venus orbiters	1970 New Start Launches: Mars - 1975 Venus - 1972, 1973, 1975	1970 New Start Launches: Mars - 1973, 1975 Venus - 1972, 1973, 1975		Measurements of the planetary environment, including particles and fields, RF occultation, and micrometeoroids; synoptic mapping of solar wind interaction; planet gravitational figure.
Mars: Mariner flyby, 1969	Baseline Launch: 1969			Equatorial and southern polar cap flyby; television and thermal trace across surface; surface and atmosphere composition; RF occultation; celestial mechanics.
Mars: Mariner orbiter, 1971	Baseline Launch: 1971			Television and IR mapping of southern and mid-latitudes; atmospheric composition, RF occultation, and celestial mechanics.
Mars: Mariner orbiter, 1973	1971 New Start Launch: 1973	None		Same as 1971 orbiter, but northern latitudes.
Mars: Orbiter - Small Hard Lander	Baseline (1969 New Start) Launches: 1973(2)			Orbital entry, and surface science; 30-lb surface payload, includes imagery and minimum life detection; one week lifetime; requires hardened instrumentation.
Mars: Orbiter - Small Soft Lander	1971 New Start Launches: 1975(2)	None		30-50 lb surface science payload; biological emphasis, TV; lifetime of one week - 3 months; orbital and entry science as before.
Venus: Mariner Flyby - Atmospheric Probes	1970 New Start Launches: 1973(2)	1972 New Start Launch: 1975		Direct measurements of atmospheric profiles of pressure, temperature, density, and composition; possibly followed by floating probe on second mission.
Mercury: Flyby, via Venus	1970 New Start Launches: 1973, 1975	1970 New Start Launch: 1973		TV, atmospheric composition, microwave brightness temperature, RF occultation, and celestial mechanics at both planets.
Jupiter: Pioneer F-G	Baseline (1969 New Start) Launches: 1972, 1973			Particles and fields measurements out to and at Jupiter (5 AU); measure of particulate matter in asteroid belt.
Jupiter: Advanced Flyby (1974)	None			Precursor to Grand Tour; TV at Jupiter; particles and fields; cosmic rays, etc. out to 10 AU.

FIGURE 6-14 - ASTRONOMY ($3.8B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Sounding Rockets	Baseline Level until 1972			Provides preliminary surveys in the UV, IR, X-ray, and radio regions. Used for development and calibration of satellite instrumentation.
OAO B-C	Baseline Launches: 1969, 1970			Sophisticated, automated observatories emphasizing broad study of astronomical objects other than the sun.
OAO D-E	1971 New Start Launches: 1973, 1975			
OSO G-H	Baseline Launches: 1969, 1970			Provides measurements of variability of Extreme Ultraviolet and X-ray solar spectra over a portion of the Solar cycle.
OSO I-K	1971 New Start Launches: 1973, 1974, 1976			Solar minimum and quiescent solar studies of corona, X-ray, UV from small Solar regions.
ATM A	Baseline Launch: 1971			Manned solar observatory. First major use of of man for support of astronomical observations. Provides observations of transient solar phenomena near or shortly after solar maximum
Follow-on ATM's	1971 New Start Launches: ATM B in 1974, others thereafter	None		ATM B will be a manned X-ray observatory. Later ATM's continue solar observations and perhaps include a large stellar telescope and observations of high energy particles.
NASO	Maximum progress toward NASO in mid-1980's of three programs.	Limited progress toward the NASO		National Astronomical Space Observatory. The space analog of Palomar, Kitt Peak, and Greenbank observatories combined.
Airplane Observatory	Common to all programs			Celestial observations from the near-IR to millimeter wavelengths.
Orbital Workshop Experiments	In all programs, small experiments compatible with Orbital Workshop environment will be integrated into the manned flight program as space becomes available.			
Explorers	Common to all programs Launches: 1970, 1971, 1972(2), 1973(3), 1974(4), 1975(4)			Small scientific satellites of several kinds including Radio Astronomy Explorers and Small Astronomical Satellites.

FIGURE 6-1.5 - SPACE PHYSICS ($3.8B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Baseline Projects	Common to all programs			
Follow-On Program IMP Explorers	1972 New Start Launch: 1975	1971 New Start Launch: 1974		Monitoring of radiation environment in cislunar space.
Atmospheric Explorers	1971 New Start Launches: 1973, 1974	1970 New Start Launches: 1972, 1973		Provides data on atmosphere in low Earth orbit.
Small Scientific Satellites (SSS)	1971 New Start Launches: 1973, 1975	1970 New Start Launches: 1972, 1974		Small, relatively inexpensive satellites featuring maximum commonality and versatility. Provides flexible, quick response experiment platform.
Cluster Satellite	None			Four small satellites launched together. Provides data for distinguishing between temporal and spatial variations in the shock, magnetopause, and magnetosphere.
Pioneer H, I, ...	None			A continuing series of satellites designed for investigating the interplanetary medium at a distance from the Earth.
Solar Probe	1971 New Start Launches: 1974, 1975	1970 New Start Launches: 1973, 1974		Cooperative venture with Germany. Provides data on interplanetary environment from 1.3 to 1 AU.
Meteoroid Explorer	None			Meteoroid flux and density measurements near 1 AU.
Relativity Satellite	1973 New Start Launch: 1976	1972 New Start Launch: 1975		Provides test of general relativity by comparing clock rates in orbit and on the ground.
Planetary Cruise Mode Experiments	Common to all programs			Physics experiments on Pioneer F & G (Planetary Program).

FIGURE 6-1.6 - SPACE BIOLOGY ($3.8B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Biosatellite A-F	Baseline Launches: 1969, 1970, 1971, 1972			Satellites provide 21-day and 30 day life support packages, provision for payload recovery. Experiments on effects of space environment on primates, plants, small animals, other organisms.
Follow-On Biosatellite	None	1970 New Start Launches: 1973, 1974, 1975		Same class vehicles as Biosatellites A through F, minor improvements as indicated by experience.
Improved Biosatellite	None			Same basic design as earlier Biosatellites C-F with minor improvements to facilitate modular experiment packaging. Payload increased to 300 lbs.
Biopioneer	None	1970 New Start Launches: 1973, 1974		Small spacecraft capable of supporting biological specimens in heliocentric orbit (near 1 AU) for one year. Investigates effects of removal from Earth environment on biorhythms.
Bio-Explorer	None			Small spacecraft (scientific payload 40-150 lbs) for use with relatively simple experiments not requiring recovery.

FIGURE 6-1.7 - ADVANCED SPACE TECHNOLOGY ($3.8B)

PROJECT	CONQUEST	BALANCED	RETURNS	
Space Vehicles, Chemical Propulsion, Space Power & Electric Propulsion, Human Factors, Electronics	$250M/yr level-of-effort commencing in FY71. FY70 at FY69 run out level ($158M).			
Nuclear Rockets	NERVA program canceled.			

FIGURE 6-18 - SPACE APPLICATIONS ($3.8B)

<table>
<tr><th>PROJECT</th><th>CONQUEST</th><th>BALANCED</th><th>RETURNS</th><th>PROJECT DESCRIPTION</th></tr>
<tr><td>Meteorology
Nimbus A-F</td><td colspan="3">Baseline
Launches: 1969, 1970, 1972, 1973</td><td rowspan="2">Polar orbit, Provide global coverage for meteorological R&D and flight testing. Sensor development to eventually provide data required for long-range numerical forecasting.</td></tr>
<tr><td>Nimbus G-H</td><td colspan="2">None until late 1970's</td><td>1972 New Start
Launches: 1975, ...</td></tr>
<tr><td>Sounding Rockets</td><td colspan="2">160 per year</td><td>200 per year</td><td></td></tr>
<tr><td>ATS - Meteorological Satellites</td><td colspan="2">1973 New Start
Launch: 1975</td><td>1972 New Start
Launch: 1974</td><td>R&D satellites for observations from synchronous orbit. Day and night cloud mapping and data on vertical atmospheric structure and dynamics, in support of improved short-range forecasting.</td></tr>
<tr><td>Tiros M</td><td colspan="3">Baseline
Launch: 1969</td><td rowspan="2">Development of advanced polar-orbiting operational prototype satellite systems and improved sensors in support of the National Operational Meteorological Satellite System.</td></tr>
<tr><td>Tiros Follow-On</td><td colspan="2">1971 New Start
Launch: 1973</td><td>1970 New Start
Launches: 1973(2)</td></tr>
<tr><td>World Weather Watch</td><td colspan="3">1972 New Start
Launch: 1975, ...</td><td>Polar-orbiting Nimbus-type observatories providing global 3-D data on atmospheric dynamics, cloud and precipitation patterns, and surface temperatures. Supports GARP.</td></tr>
<tr><td>Low-Altitude Equatorial Satellites</td><td colspan="2">1971 New Start
Launch: 1972</td><td>1970 New Start
Launch: 1971</td><td>Provide data on tropical convective systems not provided with sufficient resolution or frequency by synchronous or polar-orbiting satellites.</td></tr>
<tr><td>Synchronous Meteorological Satellites</td><td colspan="3">Baseline
Launch: 1969</td><td>Development and flight testing of Integrated Systems Experiment prototype synchronous meteorological satellites.</td></tr>
<tr><td>Navigation/Traffic Control
Navigation and Traffic Control Spacecraft</td><td colspan="2">None</td><td>1972 New Start
Launches: 1974, 1975</td><td>Development of technology for marine and aircraft navigation, traffic control, and related communications. Responsive to request of DOT and SST.</td></tr>
<tr><td>Geodesy
GEOS C</td><td colspan="3">1970 New Start
Launch: 1970</td><td>Geodetic data plus test-flight of a satellite-borne altimeter. This satellite is reconfigured back-up vehicle from GEOS-II flight. New FY70 funding required for reconfiguration.</td></tr>
<tr><td>GEOS D</td><td colspan="2">None</td><td>1970 New Start
Launch: 1972</td><td>Provides operational satellite altimeter to support oceanography, investigations of mean sea level and tides.</td></tr>
<tr><td></td><td colspan="3">- Continued -</td><td></td></tr>
</table>

FIGURE 6-1.8 - SPACE APPLICATIONS ($3.8B) (CONTINUED)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Earth Resources Survey				
ERTS Multiple Sensor Missions	1971 New Start Launches: 1973, 1975		1970 New Start Launches: 1971, 1973	Development of technology for definition of an operational Earth resources survey system.
ERS Limited Objective Missions	1971 New Start Launches: 1972, 1973, 1974, 1975		1970 New Start Launches: 1971, 1972, 1973, 1974	Flights to test engineering subsystems and determine the effectiveness of individual sensor systems.
ERTS Integrated Systems Experiments	None		1972 New Start Launch: 1974	Operational prototype Earth Resources Survey satellite.
AAP Experiments	An experiment complement of 4 instruments will be developed to fly on a 1974 or later manned flight.		An experiment complement of 6 instruments for the 1971 AAP workshop, 8 for 1975, more for 1977 and beyond.	
ERS Aircraft	Support at $6.5 M level in 1970, $9.2 M/year thereafter.		Support at $11 M/yr level commencing 1970.	Development of technology for Earth resource surveys from aircraft.
Communications/ATS				
ATS E-G	Baseline Launches: 1969, 1972, 1973			Develops cloud surveillance, communications, stabilization, and navigation technology in synchronous orbit. Some scientific experiments also included
ATS H-J	1972 New Start Launch: Post-1975		1971 New Start Launch: 1975, ...	
Data Relay Satellite System	None		1971 New Start Launches: 1974, 1975(BU)	Several synchronous satellites capable of tracking and data relay from Earth-orbital missions, manned or automated. Offers increased coverage at reduced cost over ground network.
Community TV Broadcast Satellites	None			Provides capability for transmitting 3 to 6 high quality TV programs directly from synchronous orbit to moderate cost, specialized institutional receivers.
Direct TV Broadcast Satellites	None			Provides capability to transmit single-channel monochrome or color TV to low-cost augmented home receivers.

Figure 6-2
Accomplishments ($4.1B)

Figure 6-2

Program Accomplishments - $4.1 B/yr Funding Level

FIGURE 6-2.1 - EXTENSION OF MANNED SPACE FLIGHT CAPABILITY ($4.1B)

CONQUEST	BALANCED	RETURNS
Same as "Balanced."	The Extension of Manned Space Flight program builds on the experience expected to accrue from AAP missions in 1971 and 1972. The AAP program consists of one 28-day mission and two 56-day missions. The second mission emphasizes medical experiments, the third, solar astronomy using the ATM. An Earth Orbital Space Laboratory will provide a focus for the evolution of long-duration manned space systems in the 1974 to 1978 time frame. A large laboratory will be launched into orbits of 200 n.m. and up to 90° inclination using two-stage versions of the Saturn V. For higher energy orbits, the three-stage Saturn V will be used. The laboratory is an integral nine-man device containing all the essential life support and environmental functions of a space station. A new spacecraft for crew logistics will be developed. This logistics spacecraft will be launched with the Titan IIIM (or possibly the Saturn-IB). After two qualification launches of the new logistic system, the first laboratory launch occurs in late-1974. Crew-logistics launches will occur at 90-day intervals. By mid-1975 the crew complement of this one-year laboratory will reach nine men. A new two-year, nine-man laboratory will be launched in early 1976. Applications experiments will be emphasized in the second mission built around experience acquired in the first mission.	The Extension of Manned Space Flight program builds on the experience expected to accrue from AAP missions in 1971 and 1972. The AAP program consists of one 28-day mission and two 56-day missions. The second mission emphasizes medical experiments, the third, solar astronomy using the ATM. An Earth Orbital Space Laboratory will provide a focus for the evolution of long-duration manned space systems in the 1974 to 1978 time frame. The laboratory will be assembled from small modules launched by the Saturn-IB into orbits of 200 n.m. by 50° inclination. New development activity will be limited to the laboratory and the service module. The service module provides all orbital propulsion, supports the Command Module while in transit, and carries the stabilization and control system for orbital assembly. After flight qualification of the new hardware, the first mission will be launched in mid-1974. An unmanned launch of a subsystem module will be closely followed by the three astronauts in their crew module. The unmanned experiment module is launched 60 days later, completing the orbital laboratory. Crew logistics launches occur at 90-day intervals thereafter. By not returning the second crew during the third crew rotation launch, the program can provide for six men in orbit by early 1975, and maintain this complement through completion of a one-year mission. A new two-year, six-man laboratory will be launched in mid-1975. Applications experiments will be emphasized in the second mission based on experience acquired in the first mission.

FIGURE 6-2.2 - LUNAR EXPLORATION ($4.1B)

CONQUEST	BALANCED	RETURNS
One Apollo and two Post-Apollo manned landings in 1969-1971. The Apollo mission will include limited geological surveys, sample collection, and photography on the surface and from the Command Module. The two Post-Apollo missions provide landings at features of particular interest, with ALSEP deployment. The astronaut's range is about 1 km by walking on these missions. A two-year gap follows the second Post-Apollo landing in early 1971. Three extended Apollo missions follow, one in late 1973, two in 1974. The extended Apollo missions will provide 3-day staytime on the lunar surface. Improved astronaut mobility (10 km radius) and greater science payload characterizes these missions. During the surface mission, the CSM will conduct photographic and remote sensing experiments and may deploy subsatellites for long-term particle and field measurements. Dual Launches begin in early 1975 and proceed at one-year intervals thereafter.	One Apollo and three Post-Apollo manned landings in 1969-1971. The Apollo missions will include limited geological surveys, sample collection and photography on the surface and from the Command Module. The latter three missions provide landings at features of particular interest, with ALSEP deployment. The astronaut's range is about 1 km by walking on these missions. An 18-month gap follows the third Post-Apollo landing in early 1971. In late 1972 a series of four Extended Apollo missions begins: one in 1972, one in 1973, and two in 1974. The Extended Apollo missions provide 3-day staytime on the lunar surface. These missions are supported by automated missions beginning in mid-1972 and extending through late 1974. Four advanced orbiters support the manned landings with high-resolution photography and remote sensing for site selection, science planning, and lunar-wide surveys. Four Automated Surface Vehicle launches deliver Dual Mode Rovers, Remote Geophysical Monitors, and Science Stations to the lunar surface. The Science Station operates at the landing site. The Rover performs a long-range automated traverse, collecting samples and deploying long-lived seismic stations as it progresses. At the end of the traverse, the Rovers are intended to rendezvous with manned landings for sample return. Following the fourth Extended Apollo mission in late-1974 Dual Launch missions begin in early 1975 and proceed at one year intervals thereafter.	Same as "Balanced."

FIGURE 6-2.3 - PLANETARY EXPLORATION ($4.1B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Small Mars/Venus orbiters	1970 New Start Launches: Mars - 1975 Venus - 1972, [illegible]	1970 New Start Launches: Mars - 1973, 1975 Venus - 1972, 1973, 1975		Measurements of the planetary environment, including particles and fields, RF occultation, and micrometeoroids; synoptic mapping of solar wind interaction; planet gravitational figure.
[illegible]	Baseline Launch: 1969			[illegible] vision and thermal trace across surface, surface and atmosphere composition; RF occultation; celestial mechanics.
Mars: Mariner orbiter, 1971	Baseline Launch: 1971			Television and IR mapping of southern and mid-latitudes; atmospheric composition, RF occultation, and celestial mechanics.
Mars: Mariner orbiter, 1973	1971 New Start* Launch: 1973(2)	None		Same as 1971 orbiter, but northern latitudes.
Mars: Orbiter - Small Hard Lander	Baseline (1969 New Start) Launch: 1973(2)	Baseline (1969 New Start) Launches: 1973(2), 1975(2)		Orbital entry, and surface science; 30-lb surface payload, includes imagery and minimum life detection; one week lifetime; requires hardened instrumentation.
Mars: Orbiter - Small Soft Lander	1971 New Start Launches: 1975(2)	None		30-50 lb surface science payload; biological emphasis, TV; lifetime of one week - 3 months; orbital and entry science as before.
Venus: Mariner Flyby - Atmospheric Probes	1970 New Start Launches: 1973(2)	1972 New Start Launches: 1975(2)		Direct measurements of atmospheric profiles of pressure, temperature, density, and composition; possibly followed by floating probe on second mission.
Mercury: Flyby, via Venus	1970 New Start Launches: 1973, 1975			TV, atmospheric composition, microwave brightness temperature, RF occultation, and celestial mechanics at both planets.
Jupiter: Pioneer F-G	Baseline (1969 New Start) Launches: 1972, 1973			Particles and fields measurements out to and at Jupiter (5 AU); measure of particulate matter in asteroid belt.
Jupiter: Advanced Flyby (1974)	None	1971 New Start Launch: 1974		Precursor to Grand Tour; TV at Jupiter; particles and fields; cosmic rays, etc. out to 10 AU.

FIGURE 6-2.4 - ASTRONOMY ($4.1B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Sounding Rockets	Level of activity steadily increasing to 44 shots in 1975			Provides preliminary surveys in the UV, IR, X-ray, and radio regions. Used for development and calibration of satellite instrumentation.
OAO B-C	Baseline Launches: 1969, 1970			Sophisticated, automated observatories emphasizing broad study of astronomical objects other than the sun.
OAO D-E	1970 New Start Launches: 1972, 1974			
OSO G-H	Baseline Launches: 1969, 1970			Provides measurements of variability of Extreme Ultraviolet and X-ray solar spectra over a portion of the Solar cycle.
OSO I-K	1970 New Start Launches: 1972, 1973, 1974			Solar minimum and quiescent solar studies of corona, X-ray, UV from small Solar regions.
ATM A	Baseline Launch: 1971			Manned solar observatory. First major use of of man for support of astronomical observations. Provides observations of transient solar phenomena near or shortly after solar maximum
Follow-on ATM's	1971 New Start Launches: ATM B in 1974, others thereafter			ATM B will be a manned X-ray observatory. Later ATM's continue solar observations and perhaps include a large stellar telescope and observations of high energy particles.
NASO	NASO in 1983	NASO in 1985		National Astronomical Space Observatory. The space analog of Palomar, Kitt Peak, and Greenbank observatories combined.
Airplane Observatory	Common to all programs			Celestial observations from the near-IR to millimeter wavelengths.
Orbital Workshop Experiments	In all programs, small experiments compatible with Orbital Workshop environment will be integrated into the manned flight program as space becomes available.			
Explorers	Launches: 1970, 1971, 1972(3), 1974(4), 1975(4)	Launches: 1970, 1971, 1972(2), 1973(3), 1974(4), 1975(4)		Small scientific satellites of several kinds including Radio Astronomy Explorers and Small Astronomical Satellites.

FIGURE 6-2.5 - SPACE PHYSICS ($4.1B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Baseline Projects	Common to all programs			
Follow-On Program IMP Explorers	1971 New Start Launch: 1974	1970 New Start Launches: 1973, 1974		Monitoring of radiation environment in cislunar space.
Atmospheric Explorers	1970 New Start Launches: 1972, 1973, 1974, 1975			Provides data on atmosphere in low Earth orbit.
Small Scientific Satellites (SSS)	1970 New Start Launches: 1973, 1974	1970 New Start Launches: 1972,		Small, relatively inexpensive satellites featuring maximum commonality and versatility. Provides flexible, quick response experiment platform.
Cluster Satellite	None	1971 New Start Launch: 1974		Four small satellites launched together. Provides data for distinguishing between temporal and spatial variations in the shock, magnetopause, and magnetosphere.
Pioneer H, I, ...	None	1973 New Start Launch: 1975		A continuing series of satellites designed for investigating the interplanetary medium at a distance from the Earth.
Solar Probe	1970 New Start Launches: 1973, 1974			Cooperative venture with Germany. Provides data on interplanetary environment from 1.3 to 1 AU.
Meteoroid Explorer	None	1971 New Start Launch: 1974,		Meteoroid flux and density measurements near 1 AU.
Relativity Satellite	1972 New Start Launch: 1975	1972 New Start Launch: 1973		Provides test of general relativity by comparing clock rates in orbit and on the ground.
Planetary Cruise Mode Experiments	Common to all programs			Physics experiments on Pioneer F & G (Planetary Program).

FIGURE 6-2.6 - SPACE BIOLOGY ($4.1B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Biosatellite A-F	Baseline Launches: 1969, 1970, 1971, 1972			Satellites provide 21-day and 30 day life support packages, provision for payload recovery. Experiments on effects of space environment on primates, plants, small animals, other organisms.
Follow-On Biosatellite	1970 New Start Launches: 1973, 1974 1975	1970 New Start Launches: 1973, 1974		Same class vehicles as Biosatellites A through F, minor improvements as indicated by experience.
Improved Biosatellite	None	1970 New Start Launches: 1975, ...		Same basic design as earlier Biosatellites C-F with minor improvements to facilitate modular experiment packaging. Payload increased to 300 lbs.
Biopioneer	1970 New Start Launches: 1973, 1974			Small spacecraft capable of supporting biological specimens in heliocentric orbit (near 1 AU) for one year. Investigates effects of removal from Earth environment on biorhythms.
Bio-Explorer	None	1970 New Start Launches: 1972, 1973		Small spacecraft (scientific payload 40-150 lbs) for use with relatively simple experiments not requiring recovery.

FIGURE 6-2.7 - ADVANCED SPACE TECHNOLOGY ($4.1B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Space Vehicles, Chemical Propulsion, Space Power & Electric Propulsion, Human Factors, Electronics	In all options, level-of-effort reaches $290M in 1974.			
Nuclear Rockets	Aggressive NERVA development program at $50M/year level.			

FIGURE 6-2.8 - SPACE APPLICATIONS ($4.1B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Meteorology				
Nimbus A-F	Baseline Launches: 1969, 1970, 1972, 1973			Polar orbit. Provide global coverage for meteorological R&D and flight testing. Sensor development to eventually provide data required for long-range numerical forecasting.
Nimbus G-H	None until late 1970's	1972 New Start Launches: 1975, ...	1971 New Start Launches: 1974, 1975	
Sounding Rockets	160 per year	200 per year	210 per year	
ATS - Meteorological Satellites	1973 New Start Launch: 1975	1972 New Start Launch: 1974	1971 New Start Launches: 1974(2)	R&D satellites for observations from synchronous orbit. Day and night cloud mapping and data on vertical atmospheric structure and dynamics, in support of improved short-range forecasting.
Tiros M	Baseline Launch: 1969			Development of advanced polar-orbiting operational prototype satellite systems and improved sensors in support of the National Operational Meteorological Satellite System.
Tiros Follow-On	1973 New Start Launch: 1975	1971 New Start Launch: 1973	1970 New Start Launch: 1973	
World Weather Watch	1971 New Start Launch: 1973	1970 New Start Launches: 1973(2)	1970 New Start Launches: 1973(2), 1974(BU)	Polar-orbiting Nimbus-type observatories providing global 3-D data on atmospheric dynamics, cloud and precipitation patterns, and surface temperatures. Supports GARP.
Low-Altitude Equatorial Satellites	1973 New Start Launch: 1975		1970 New Start Launches: 1972, 1973	Provide data on tropical convective systems not provided with sufficient resolution or frequency by synchronous or polar-orbiting satellites.
Synchronous Meteorological Satellites	Baseline Launch: 1969			Development and flight testing of Integrated Systems Experiment prototype synchronous meteorological satellites.
Navigation/Traffic Control				
Navigation and Traffic Control Spacecraft	None	1972 New Start Launches: 1974, 1975	1970 New Start Launches: 1972, 1973	Development of technology for marine and aircraft navigation, traffic control, and related communications. Responsive to request of DOT and SST.
Geodesy				
GEOS C	1970 New Start Launch: 1970			Geodetic data plus test-flight of a satellite-borne altimeter. This satellite is reconfigured back-up vehicle from GEOS-II flight. New FY70 funding required for reconfiguration.
GEOS D	None	1970 New Start Launch: 1972		Provides operational satellite altimeter to support oceanography, investigations of mean sea level and tides.

- Continued -

FIGURE 6-2.8 - SPACE APPLICATIONS ($4.1B) (CONTINUED)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Earth Resources Survey				
ERTS Multiple Sensor Missions	1971 New Start Launches: 1973, 1975	1970 New Start Launches: 1971, 1973	1970 New Start Launches: 1971, 1972 1974, 1975	Development of technology for definition of an operational Earth resources survey system.
ERS Limited Objective Missions	1971 New Start Launches: 1971, 1973 1974, 1975	1970 New Start Launches: 1971, 1972 1973, 1974	1970 New Start Launches: 1970, 1971, 1972 1973, 1974	Flights to test engineering subsystems and determine the effectiveness of individual sensor systems.
ERTS Integrated Systems Experiments	None	1972 New Start Launch: 1974	1971 New Start Launch: 1973	Operational prototype Earth Resources Survey satellite.
AAP Experiments	Experiment complement of 4 instruments for a 1974 or later manned flight.	Experiment complement of 6 instruments for 1971 AAP, 8 for 1975, more for 1977 and beyond.	Experiment complement of 6 instruments for 1971 AAP, 10 for 1974, more for 1977 and beyond.	
ERS Aircraft	Support at $6.5 M level in 1970, $0.2 M/yr thereafter.	Support at $11 M/yr level commencing 1970.	Support at $12 M/yr level commencing 1970.	Development of technology for Earth resource surveys from aircraft.
Communications/ATS				
ATS E-G	Baseline Launches: 1969, 1972, 1973			Develops cloud surveillance, communications, stabilization, and navigation technology in synchronous orbit. Some scientific experiments also included
ATS H-J	1972 New Start Launch: 1976	1970 New Start Launches: 1974, 1975		
Data Relay Satellite System	1971 New Start Launches: 1974, 1975(BU)	1970 New Start Launches: 1974, 1975(BU)		Several synchronous satellites capable of tracking and data relay from Earth-orbital missions, manned or automated. Offers increased coverage at reduced cost over ground network.
Community TV Broadcast Satellites	None	1971 New Start Launches: 1975, 1976(BU)	1970 New Start Launches: 1974, 1975(BU)	Provides capability for transmitting 3 to 6 high quality TV programs directly from synchronous orbit to moderate cost, specialized institutional receivers.
Direct TV Broadcast Satellites	None	1972 New Start Launch: 1976	1971 New Start Launch: 1975	Provides capability to transmit single-channel monochrome or color TV to low-cost augmented home receivers.

Figure 8-3
Accomplishments ($3.5B)

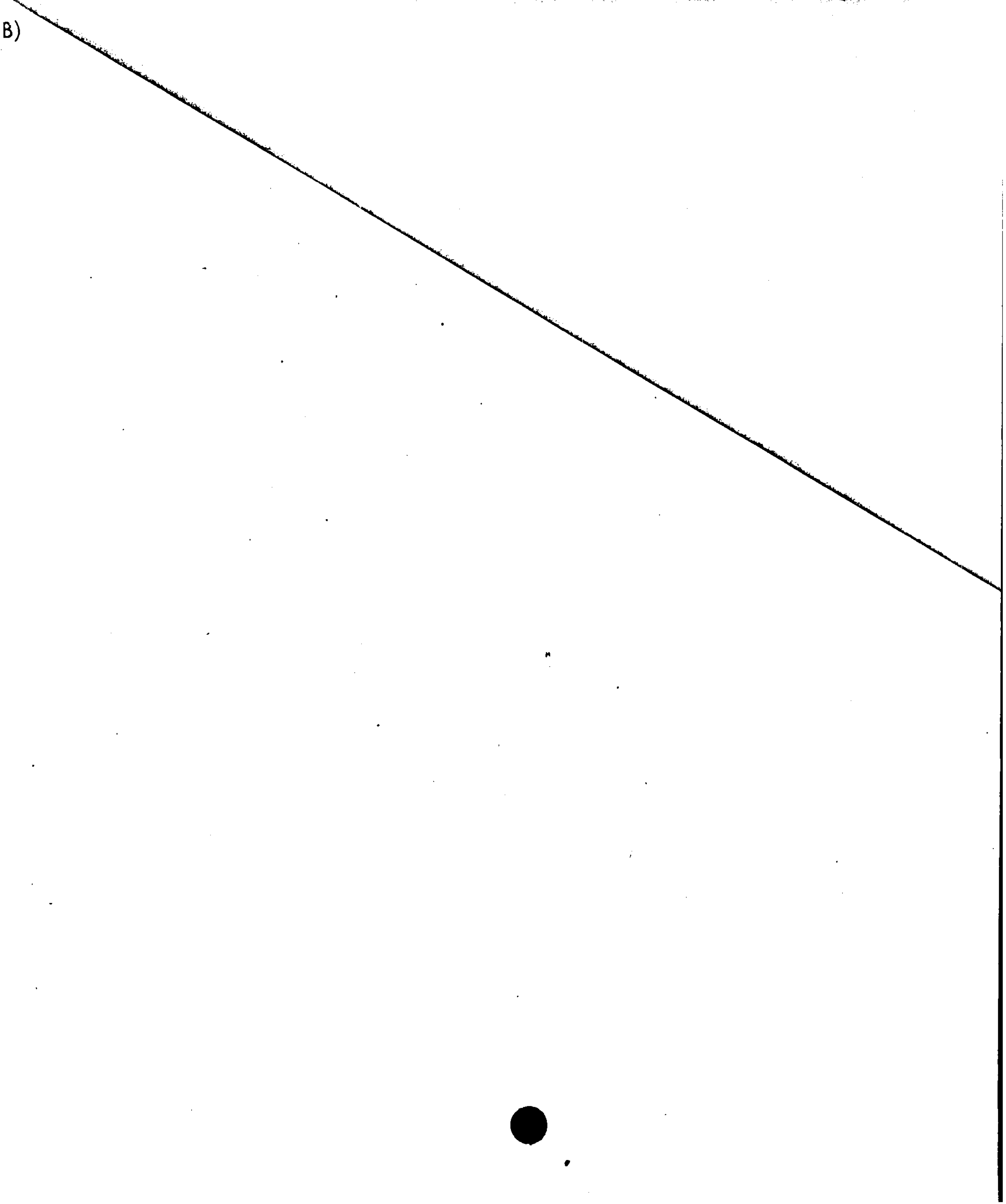

Figure 6-3

Program Accomplishments - $3.5 B/yr Funding Level

Figure	Program
6-3.1	EMSF
6-3.2	Lunar Exploration
6-3.3	Planetary Exploration
6-3.4	Astronomy
6-3.5	Space Physics
6-3.6	Space Biology
6-3.7	Advanced Space Technology
6-3.8	Space Applications

FIGURE 6-3.1 - EXTENSION OF MANNED SPACE FLIGHT CAPABILITY ($3.5B)

CONQUEST	BALANCED	RETURNS
Same as "Balanced."	The Extension of Manned Space Flight program builds on the experience expected to accrue from AAP missions in 1971 and 1972. The AAP program consists of a 28-day mission and a 56-day mission. The second mission emphasizes medical experiments. The third AAP mission is cancelled in this program. An Earth Orbital Space Laboratory will provide a focus for the evolution of long-duration manned space systems in the 1974 to 1978 time frame. A large laboratory will be launched into orbits of 200 n.m. and up to 90° inclination using two-stage versions of the Saturn V. For higher energy orbits, the three-stage Saturn V will be used. The laboratory is an integral nine-man device containing all the essential life support and environmental functions of a space station. A new spacecraft for crew logistics will be developed. This logistics spacecraft will be launched with the Titan IIIM (or possibly the Saturn-IB). After two qualification launches of the new logistic system, the first laboratory launch occurs in late-1974. Crew-logistics launches will occur at 90-day intervals. By mid-1975 the crew complement of this one-year laboratory will reach nine men. A new two-year, nine-man laboratory will be launched in early 1976. Applications experiments will be emphasized in the second mission built around experience acquired in the first mission.	The Extension of Manned Space Flight program builds on the experience expected to accrue from AAP missions in 1971 and 1972. The AAP program consists of one 28-day mission and two 56-day missions. The second mission emphasizes medical experiments, the third, solar astronomy using the ATM. An Earth Orbital Space Laboratory will provide a focus for the evolution of long-duration manned space systems in the 1974 to 1978 time frame. The laboratory will be assembled from small modules launched by the Saturn-IB into orbits of 200 n.m. by 50° inclination. New development activity will be limited to the laboratory and the service module. The service module provides all orbital propulsion, supports the Command Module while in transit, and carries the stabilization and control system for orbital assembly. After flight qualifications of the new hardware, the first mission will be launched in mid-1974. An unmanned launch of a sybsystem module will be closely followed by the three astronauts in their crew module. The unmanned experiment module is launched 60 days later, completing the orbital laboratory. Crew logistics launches occur at 90-day intervals thereafter. By not returning the second crew during the third crew rotation launch, the program can provide for six men in orbit by early 1975, and maintain this complement through completion of a one-year mission. A new two-year, six-man laboratory will be launched in mid-1975. Applications experiments will be emphasized in the second mission based on experience acquired in the first mission.

FIGURE 6-3.2 - LUNAR EXPLORATION ($3.5B)

CONQUEST	BALANCED	RETURNS
Same as "Balanced."	One Apollo and two Post-Apollo manned landings in 1969-1971. The Apollo mission will include limited geological surveys, sample collection, and photography on the surface and from the Command Module. The two Post-Apollo missions provide landings at features of particular interest, with ALSEP deployment. The astronaut's range is about 1 km by walking on these missions. A two-year gap follows the second Post-Apollo landing in early 1971. Three extended Apollo missions follow, one in late 1973, two in 1974. The extended Apollo missions will provide 3-day staytime on the lunar surface, improved astronaut mobility (10 km radius), and greater science payload. During the surface mission, the CSM will conduct photographic and remote sensing experiments and may deploy subsatellites for long-term particle and field measurements. In this program no provision is made for Saturn V vehicles for lunar exploration beyond SA-513.	Same as "Balanced."

FIGURE 6-3.3 - PLANETARY EXPLORATION ($3.5B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Small Mars/Venus orbiters	1970 New Start Launches: Mars - 1973, 1975 Venus - 1972, 1973, 1975			Measurements of the planetary environment, including particles and fields, RF occultation, and micrometeoroids; synoptic mapping of solar wind interaction; planet gravitational figure.
Mars: Mariner flyby, 1969	Baseline Launch: 1969			Equatorial and southern polar cap flyby; television and thermal trace across surface; surface and atmosphere composition; RF occultation; celestial mechanics.
Mars: Mariner orbiter, 1971	Baseline Launch: 1971			Television and IR mapping of southern and mid-latitudes; atmospheric composition, RF occultation, and celestial mechanics.
Mars: Mariner orbiter, 1973	1971 New Start Launch: 1973	None		Same as 1971 orbiter, but northern latitudes.
Mars: Orbiter - Small Hard Lander	Baseline (1969 New Start) Launches: 1973(2)			Orbital entry, and surface science; 30-lb surface payload, includes imagery and minimum life detection; one week lifetime; requires hardened instrumentation.
Mars: Orbiter - Small Soft Lander	1971 New Start Launches: 1975(2)	None		30-50 lb surface science payload; biological emphasis, TV; lifetime of one week - 3 months; orbital and entry science as before.
Venus: Mariner Flyby - Atmospheric Probes	None	1972 New Start Launch: 1975		Direct measurements of atmospheric profiles of pressure, temperature, density, and composition; possibly followed by floating probe on second mission.
Mercury: Flyby, via Venus	1970 New Start Launches: 1973, 1975	1970 New Start Launch: 1973		TV, atmospheric composition, microwave brightness temperature, RF occultation, and celestial mechanics at both planets.
Jupiter: Pioneer F-G	Baseline (1969 New Start) Launches: 1972, 1973			Particles and fields measurements out to and at Jupiter (5 AU); measure of particulate matter in asteroid belt.
Jupiter: Advanced Flyby (1974)	None			Precursor to Grand Tour; TV at Jupiter; particles and fields; cosmic rays, etc. out to 10 AU.

FIGURE 6-3.4 - ASTRONOMY ($3.5B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Sounding Rockets		Baseline Level until 1972		Provides preliminary surveys in the UV, IR, X-ray, and radio regions. Used for development and calibration of satellite instrumentation.
OAO B-C		Baseline Launches: 1969, 1970		Sophisticated, automated observatories emphasizing broad study of astronomical objects other than the sun.
OAO D-E		1971 New Start Launches: 1973, 1975		
OSO G-H		Baseline Launches: 1969, 1970		Provides measurements of variability of Extreme Ultraviolet and X-ray solar spectra over a portion of the Solar cycle.
OSO I-K		1970 New Start Launches: 1973, 1974, 1976		Solar minimum and quiescent solar studies of corona, X-ray, UV from small Solar regions.
ATM A		Baseline Launch: 1971		Manned solar observatory. First major use of of man for support of astronomical observations. Provides observations of transient solar phenomena near or shortly after solar maximum
Follow-on ATM's		None		ATM B will be a manned X-ray observatory. Later ATM's continue solar observations and perhaps include a large stellar telescope and observations of high energy particles.
NASO		Minimal progress toward the NASO		National Astronomical Space Observatory. The space analog of Palomar, Kitt Peak, and Greenbank observatories combined.
Airplane Observatory		Common to all programs		Celestial observations from the near-IR to millimeter wavelengths.
Orbital Workshop Experiments		In all programs, small experiments compatible with Orbital Workshop environment will be integrated into the manned flight program as space becomes available.		
Explorers		Common to all programs Launches: 1970, 1971, 1972(2), 1973(3), 1974(4), 1975(4)		Small scientific satellites of several kinds including Radio Astronomy Explorers and Small Astronomical Satellites.

FIGURE 6-3.5 - SPACE PHYSICS ($3.5B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Baseline Projects	Cancel Sunblazer in Baseline Program	Carry Out All Approved Baseline Projects		
Follow-On Program IMP Explorers	1972 New Start Launch: 1975			Monitoring of radiation environment in cislunar space.
Atmospheric Explorers	1971 New Start Launches: 1973, 1974			Provides data on atmosphere in low Earth orbit.
Small Scientific Satellites (SSS)	1971 New Start Launches: 1973, 1975			Small, relatively inexpensive satellites featuring maximum commonality and versatility. Provides flexible, quick response experiment platform.
Cluster Satellite	None			Four small satellites launched together. Provides data for distinguishing between temporal and spatial variations in the shock, magnetopause, and magnetosphere.
Pioneer H, I, ...	None			A continuing series of satellites designed for investigating the interplanetary medium at a distance from the Earth.
Solar Probe	1971 New Start Launches: 1974, 1975			Cooperative venture with Germany. Provides data on interplanetary environment from 1.3 to 1 AU.
Meteoroid Explorer	None			Meteoroid flux and density measurements near 1 AU.
Relativity Satellite	1973 New Start Launch: 1976			Provides test of general relativity by comparing clock rates in orbit and on the ground.
Planetary Cruise Mode Experiments	Common to all programs			Physics experiments on Pioneer F & G (Planetary Program).

FIGURE 6-3.6 - SPACE BIOLOGY ($3.5B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Biosatellite A-F	Cancel 1971, 1972 Biosatellites from Baseline Program Launches: 1969, 1970			Satellites provide 21-day and 30 day life support packages, provision for payload recovery. Experiments on effects of space environment on primates, plants, small animals, other organisms.
Follow-On Biosatellite	None			Same class vehicles as Biosatellites A through F, minor improvements as indicated by experience.
Improved Biosatellite	None			Same basic design as earlier Biosatellites C-F with minor improvements to facilitate modular experiment packaging. Payload increased to 300 lbs.
Biopioneer	None			Small spacecraft capable of supporting biological specimens in heliocentric orbit (near 1 AU) for one year. Investigates effects of removal from Earth environment on biorhythms.
Bio-Explorer	None			Small spacecraft (scientific payload 40-150 lbs) for use with relatively simple experiments not requiring recovery.

FIGURE 6-3.7 - ADVANCED SPACE TECHNOLOGY ($2.5B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Space Vehicles, Chemical Propulsion, Space Power & Electric Propulsion, Human Factors, Electronics	$250M/yr level-of-effort commencing in FY71. FY70 level same as FY69 ($166M).			
Nuclear Rockets	NERVA program continued at $10M/yr SRT level.			

FIGURE 6-3.8 - SPACE APPLICATIONS ($1.5B)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Meteorology				
Nimbus A-F		Baseline Launches: 1969, 1970, 1972, 1973		Polar orbit. Provide global coverage for meteorological R&D and flight testing. Sensor development to eventually provide data required for long-range numerical forecasting.
Nimbus G-H		None until late 1970's		
Sounding Rockets		160 per year		
ATS - Meteorological Satellites		1973 New Start Launch: 1975		R&D satellites for observations from synchronous orbit. Day and night cloud mapping and data on vertical atmospheric structure and dynamics, in support of improved short-range forecasting.
Tiros M		1971 New Start Launch: 1975		Development of advanced polar-orbiting operational prototype satellite systems and improved sensors in support of the National Operational Meteorological Satellite System.
Tiros Follow-On		1971 New Start Launch: 1973		
World Weather Watch		1972 New Start Launch: 1975, ...		Polar-orbiting Nimbus-type observatories providing global 3-D data on atmospheric dynamics, cloud and precipitation patterns, and surface temperatures. Supports GARP.
Low-Altitude Equatorial Satellites		1971 New Start Launch: 1972		Provide data on tropical convective systems not provided with sufficient resolution or frequency by synchronous or polar-orbiting satellites.
Synchronous Meteorological Satellites		Baseline Launch: 1969		Development and flight testing of Integrated Systems Experiment prototype synchronous meteorological satellites.
Navigation/Traffic Control				
Navigation and Traffic Control Spacecraft		None		Development of technology for marine and aircraft navigation, traffic control, and related communications. Responsive to request of DOT and SST.
Geodesy				
GEOS C		1970 New Start Launch: 1970		Geodetic data plus test-flight of a satellite-borne altimeter. This satellite is reconfigured back-up vehicle from GEOS-II flight. New FY70 funding required for reconfiguration.
GEOS D		None		Provides operational satellite altimeter to support oceanography, investigations of mean sea level and tides.
		- Continued -		

FIGURE 6-3.8 - SPACE APPLICATIONS ($3.5B) (CONTINUED)

PROJECT	CONQUEST	BALANCED	RETURNS	PROJECT DESCRIPTION
Earth Resources Survey				
ERTS Multiple Sensor Missions	1971 New Start Launches: 1973, 1975		1970 New Start Launches: 1972, 1974	Development of technology for definition of an operational Earth resources survey system.
ERS Limited Objective Missions	1971 New Start Launches: 1972, 1973, 1974, 1975		1970 New Start Launches: 1971, 1972, 1973, 1974	Flights to test engineering subsystems and determine the effectiveness of individual sensor systems.
ERTS Integrated Systems Experiments	None			Operational prototype Earth Resources Survey satellite.
AAP Experiments	An experiment complement of 4 instruments will be developed to fly on a 1974 or later manned flight.			
ERS Aircraft	Support at $6.5 M level in 1970, $9.2 M/year thereafter.		Support at $9.2 M level commencing 1970.	Development of technology for Earth resource surveys from aircraft.
Communications/ATS				
ATS E-G	Baseline Launches: 1969, 1972, 1973			Develops cloud surveillance, communications, stabilization, and navigation technology in synchronous orbit. Some scientific experiments also included
ATS H-J	1971 New Start Launch: Post-1975		1971 New Start Launch: 1975, ...	
Data Relay Satellite System	None		1971 New Start Launches: 1974, 1975(BU)	Several synchronous satellites capable of tracking and data relay from Earth-orbital missions, manned or automated. Offers increased coverage at reduced cost over ground network.
Community TV Broadcast Satellites	None			Provides capability for transmitting 3 to 6 high quality TV programs directly from synchronous orbit to moderate cost, specialized institutional receivers.
Direct TV Broadcast Satellites	None			Provides capability to transmit single-channel monochrome or color TV to low-cost augmented home receivers.

Tables 6-1/6-3
Accomplishments Summary

TABLE 6-1 - SUMMARY OF PROGRAM ACCOMPLISHMENTS $3.8B/YEAR LEVEL

PROGRAM	CONQUEST	BALANCED	RETURNS
EMSF	All programs are responsive to the broad requirements for technological information. Both Saturn V and Saturn-IB based programs will result in the development of long duration systems, provide substantial statistical information on man, and accomplish a significant effort in supporting science and applications experiments. The first year of flight will demonstrate the satisfactory performance of man through the experience of six men in space for 180 days and will establish techniques for operation of the space laboratory. On this mission prototype subsystems will be qualified and Earth-viewing and meteorological instruments will be evaluated. The second mission will extend data on man in the space environment to 24 men for 180 days. Laboratory operation will be routine. Science and applications experiments will focus on exploiting the knowledge gained in the earlier mission.		
Lunar Exploration	All major Apollo equipment is utilized, but the program provides only a limited exploration capability within the Apollo buy. Orbital science, site photography, and long-range traverses are more limited than in the "Balanced" or "Returns" programs. However, Dual Launches begin one year earlier than in the "Balanced" program. A continuing series of Dual Launches assures eventual achievement of a reasonable lunar exploration capability.	The use of mixed manned and automated systems provides a reasonable exploration capability within the Apollo buy. Of the programs considered, this program comes nearest to satisfying the scientific requirements established by both NASA and independent advisory groups. Dual Launches after 1975 increase the program's effectiveness. The automated systems used in this plan would support fully automated exploration if such a program were desired in the future.	Same as "Balanced" except no Saturn V missions beyond SA-515. Exploration beyond 1975 will require a decision either to implement an automated exploration program or to restart the manned program.
Planetary Exploration	Early, sustained Mars surface exploration. The atmosphere, particle and fields environment of Mars will be well defined. Missions inside Venus, outside Mars. Of the programs considered, this has the highest probability of Martian life detection by the late 1970's. Knowledge of the Venerian atmosphere and environment will be expanded. No extensive data on the Venus surface will be available by 1975. Grand Tour mission will yield TV, particles and fields data at Jupiter, Saturn, Uranus, and Neptune, plus data on solar wind, meteoroids, cosmic ray environment beyond Jupiter. Program contains no Venus lander, no Jupiter entry probe, and no asteroid mission.	Reduced effort in all areas compared to "Conquest" program. Minimal possibility of Martian life detection in the 1970's. Knowledge of the Venerian atmosphere and environment will be expanded. No extensive data on the Venus surface will be available by 1975. Data on the Mercury environment and atmosphere, plus surface photography, will be available by 1975. Grand Tour missions will yield TV, particles and fields data at Jupiter, Saturn, Uranus, and Neptune, plus data on solar wind, meteoroids, cosmic ray environment beyond Jupiter. Program contains no Venus lander, no Jupiter entry probe, and no asteroid mission.	
Astronomy	Scientific returns through the mid-1970's comparable in all programs. Each program provides a broad effort in both solar and stellar astronomy. Potential returns of this option are significantly greater however in the late-1970's and 1980's owing to the greater flexibility of the manned instruments in the continuing series of ATM flights leading to NASO.	Scientific returns through the mid-1970's comparable in all programs. Each program provides a broad effort in both solar and stellar astronomy. Less long term potential than the "Conquest" program, however, owing to lack of manned instruments after ATM-A in 1971.	
Space Physics	All programs have identical content though pace is slower in the "Conquest" program. Some of the scientific objectives are achieved in the region of the Earth's environment above 150 km. The Solar Probe provides measurements approaching 0.3 AU, but no provision is made for exploration beyond 1 AU. (Planetary program will provide cruise-mode experiments beyond Jupiter in the late-1970's.)		

- Continued -

TABLE 6-1 - (CONTINUED)

PROGRAM	CONQUEST	BALANCED	RETURNS
Space Biology	Provides for no flights beyond those presently approved through 1972. Provides for no advance over Biosatellite technology. Opportunities for experiments will be available on AAP and succeeding flights however. By the end of 1972, a broad, probably cursory, survey of the effects of the space environment on various organisms will have been accomplished.	One major launch per year through 1975. No advance over Biosatellite technology will be available prior to 1975-1976. Provides a broader survey of biological effects than the "Conquest" program. Opportunities for participation in manned flights will be available on AAP and succeeding flights.	
Space Applications Meteorology	Substantial risk that the basic objectives of the program will not be realized in an orderly fashion. Austerity of the program impacts overall basic meteorological research, national and international commitments, support for the Global Atmospheric Research Program, and support for ESSA. Achievement of long-range numerical forecasting not likely before late 1970's or 1980's.		Good probability of obtaining data required for an orderly and logical accomplishment of the meteorology objectives, if all flights are successful. Provides for development and testing of experimental and operational meteorological sensors and techniques. International commitments are supported.
Earth Resources Survey	An austere program based on a limited commitment to development of a national ERS program. Many objectives deferred indefinitely.		Somewhat more vigorous than the "Conquest" and "Balanced" programs. Flights come a year or more sooner, and more SRT funding.
Communication/ ATS	Substantial risk that program objectives will not be realized in an orderly fashion. Stretched ATS program delays communication experiments two years beyond optimum pace. Meteorological experiments likewise delayed. Minimal progress toward operational Community TV and Direct TV broadcast systems. Only "Returns" program includes TDRSS.		
Navigation/ Traffic Control	An austere program. Activity restricted to a small number of experimental tests on ATS and NIMBUS-type spacecraft. May not meet needs of SST's for accurate mid-ocean navigation.		Prototype navigational systems operational by mid-1970's. First launch after initiation of SST flights.
Geodesy	An austere program. No provision for development of advanced precision distance measurement techniques needed in many areas of research dealing with the dynamic Earth and the oceans.		Reasonable program. Achieves a major portion of program goals and objectives.

TABLE 6-2 - SUMMARY OF PROGRAM ACCOMPLISHMENTS $4.1B/YEAR LEVEL

PROGRAM	CONQUEST	BALANCED	RETURNS
EMSF	All programs are responsive to the broad requirements for technological information. Both Saturn V and Saturn-IB based programs will result in the development of long-duration systems, provide substantial statistical information on man, and accomplish a significant effort in both supporting science and applications experiments. The first year of flight will demonstrate the satisfactory performance of man through the experience of six men in space for 180 days and will establish techniques for operation of the space laboratory. On this mission prototype subsystems will be qualified and Earth-viewing and meteorological instruments will be evaluated. The second mission will extend data on man in the space environment to 24 men for 180 days. Laboratory operation will be routine. Science and applications experiments will focus on exploiting the knowledge gained in the earlier mission.		
Lunar Exploration	All major Apollo equipment is utilized, but the program provides only a limited exploration capability within the Apollo buy. Orbital science, site photography, and long-range traverses are more limited than in the "Balanced" or "Returns" programs. However, Dual Launches begin one year earlier than in the "Balanced" program. A continuing series of Dual Launches assures eventual achievement of a reasonable lunar exploration capability.	The use of mixed manned and automated systems provides a reasonable exploration capability within the Apollo buy. This program comes nearest of the programs considered to satisfying the scientific requirements established by both NASA and independent advisory groups. Dual launches after 1974 increase the program's effectiveness. The automated systems used in this plan would support fully automated exploration if such a program were desired in the future.	
Planetary Exploration	Early, sustained Mars surface exploration. The atmosphere, particle and fields environment of Mars will be well defined. Missions inside Venus, outside Mars. Of the programs considered, this has the highest probability of Martian life detection by the late 1970's. Knowledge of the Venerian atmosphere and environment will be expanded. No extensive data on the Venus surface will be available by 1975. Data on the Mercury environment and atmosphere, plus surface photography, will be available by 1975. Grand Tour missions will yield TV, particles and fields data at Jupiter, Saturn, Uranus, and Neptune, plus data on solar wind, meteoroids, cosmic ray environment beyond Jupiter. Program contains no Venus lander, no Jupiter entry probe, and no asteroid mission.	Reasonable, sequential exploration at Mars and Venus. Sufficient effort inside Venus and outside Mars to support future exploration. Minimal probability of Martian life detection by late-1970's. Knowledge of the Venerian atmosphere and environment will be expanded. No extensive data on the Venus surface will be available by 1975. Data on the Mercury environment and atmosphere, plus surface photography, will be available by 1975. Grand Tour missions will yield TV, particles and fields data at Jupiter, Saturn, Uranus, and Neptune, plus data on solar wind, meteoroids, cosmic ray environment beyond Jupiter. Program contains no Venus lander, no Jupiter entry probe, and no asteroid missions.	
Astronomy	Scientific returns through the mid-1970's comparable in all programs. Each program provides a broad, interrelated series of investigations. Pace of the "Conquest" Program is somewhat faster in manned astronomy in the late 1970's, and is oriented toward providing a National Astronomical Space Observatory in 1983.	Scientific returns through the mid-1970's comparable in all programs. Each program provides a broad, interrelated series of investigations. Manned instruments in the late-1970's will provide sophisticated and flexible capability for astronomy experiments above the atmosphere. Program is oriented toward providing a National Astronomical Space Observatory in 1985.	

- Continued -

TABLE 6-2 - (CONTINUED)

PROGRAM	CONQUEST	BALANCED	RETURNS
Space Physics	Achieves some of the space physics scientific objectives in the region of the Earth's environment above 150 km. The Solar Probe provides measurements approaching 0.3 AU, but no provision is made for exploration beyond 1 AU. (Planetary program will provide cruise-mode experiments beyond Jupiter in the late-1970's.)	Achieves many of the scientific objectives of the space physics program. Solar Probe provides measurements approaching 0.3 AU, but no provision is made for exploration beyond 1 AU. (Planetary program will provide cruise-mode experiments beyond Jupiter in late-1970's.) Pace of the flight program is somewhat faster than in the "Conquest" program and additional projects provide more data on the upper-atmosphere, meteoroid densities, and on interplanetary particles and fields.	
Space Biology	One major launch per year through 1975. No advance over Biosatellite technology will be available prior to 1975-1976. Provides a broad survey of biological effects of the space environment by 1975. Opportunities for participating in manned flights will be available on AAP and succeeding flights.	One major launch per year. Provides for development of an improved version of the current Biosatellite. The Improved Biosatellite should provide increased flexibility and greater capability in the post-1975 period. Prior to 1975, program will provide essentially the same accomplishments as the "Conquest" program, namely, a broad survey of the biological effects of the space environment.	
Space Applications			
Meteorology	Substantial risk that the basic objectives of the program will not be realized in an orderly fashion. Austerity of the program impacts overall basic meteorological research, national and international commitments, support for the Global Atmospheric Research Program, and support for ESSA. Achievement of long-range numerical forecasting unlikely before late-1970's or 1980's.	Good probability of obtaining data required for an orderly and logical accomplishment of the meteorology objectives, if all flights are successful. Provides for development and testing of experimental and operational meteorological sensors and techniques. International commitments are supported.	An optimum program, proceeding to fulfillment of program objectives at technologically limited pace. New starts permitted in all technologically ready areas.
Earth Resources Survey	An austere program based on a limited commitment to development of a national ERS program. Many objectives deferred indefinitely.	Somewhat more vigorous than the "Conquest" program. Flights come a year or more sooner, and more SRT funding.	
Communications/ ATS	Substantial risk that program objectives will not be realized in an orderly fashion. Stretched ATS program delays communication experiments two years beyond optimum pace. Meteorological experiments likewise delayed. Minimal progress toward operational Community TV and Direct TV broadcast systems.	A reasonable program, achieving a major portion of program goals and objectives. Pace of development of Broadcast TV satellites less than in "Returns" program, however, this has advantages in that more time is available to resolve issues involved.	
Navigation/Traffic Control	An austere program. Activity restricted to a small number of experimental tests on ATS and NIMBUS-type spacecraft. May not meet needs of SST's for accurate mid-ocean navigation.	Prototype navigation systems operational by mid-1970's. First launch is after initiation of SST flights.	
Geodesy	An austere program. No provision for development of advanced precision distance measurement techniques needed in many areas of research dealing with the dynamic Earth and the oceans.	Reasonable program. Achieves a major portion or program goals and objectives.	

TABLE 6-3 - SUMMARY OF PROGRAM ACCOMPLISHMENTS $3.5B/YEAR LEVEL

PROGRAM	CONQUEST	BALANCED	RETURNS
EMSF	All programs are responsive to the broad requirements for technological information. Both Saturn V and Saturn-IB based programs will result in the development of long duration systems, provide substantial statistical information on man, and accomplish a significant effort in supporting science and applications experiments. The first year of flight will demonstrate the satisfactory performance of man through the experience of six men in space for 180 days and will establish techniques for operation of the space laboratory. On this mission, prototype subsystems will be qualified, and Earth-viewing and meteorological instruments will be evaluated. The second mission will extend data on man in the space environment to 24 men for 180 days. Laboratory operation will be routine. Science and applications experiments will focus on exploiting the knowledge gained in the earlier mission.		
Lunar Exploration	Program provides a quite limited lunar exploration capability. Missions are restricted to improved, but Apollo-like, operations. Program weaknesses are absence of long-range traverses, limited orbital science and site photography, and a weak impetus to new technology. Substantial risk that the limited data collected will result in ambiguous conclusions. Major scientific questions may remain unanswered.		
Planetary Exploration	Program emphasizes Mars missions on a limited budget. Emphasis is achieved by deleting missions to Venus other than Explorer Orbiters and by deleting the Grand Tour and Comet missions in the late 1970's. Significant probability of detecting life on Mars, if it exists. Major scientific questions at planets other than Mars will remain unanswered in the 1970's.	Reduced effort in all areas. Minimal likelihood of Martian life detection in the 1970's. Knowledge of the Venerian atmosphere and environment will be expanded. No extensive data on the Venus surface will be available by 1975. Data on the Mercury environment and atmosphere, plus surface photography, will be available by 1975. Grand Tour missions will yield TV, particles and fields data at Jupiter, Saturn, Uranus, and Neptune, plus data on solar wind, meteoroids, cosmic ray environment beyond Jupiter. Program contains no Venus lander, no Jupiter entry probe, and no asteroid mission.	
Astronomy	Scientific returns through the mid-1970's comparable in all programs. Each program provides a broad effort in solar and stellar astronomy based on automated spacecraft. Lack of manned instruments or major new programs limits growth potential in late 1970's and 1980's.		
Space Physics	All programs have identical content with the exception of the Sunblazer project which is cancelled in the "Conquest" program. Pace is also slower in the "Conquest" program. In all programs some of the scientific objectives are achieved in the region of the Earth's environment above 150 km. The Solar Probe provides measurements approaching 0.3 AU, but no provision is made for exploration beyond 1 AU. (Planetary program will provide cruise-mode experiments beyond Jupiter in the late 1970's.)		
Space Biology	Provides for no flights beyond 1970. No advance over Biosatellite technology. Opportunities for experiments on manned flights will be available on AAP and succeeding programs, however. By the end of 1972, a cursory survey of the effects of the space environment on various organisms will have been accomplished.		One major launch per year through 1975. No advance over Biosatellite technology will be available prior to 1975-1976. By the end of 1975, program will have provided a broad, probably cursory, survey of the biological effects of the space environment. Opportunities for participation in manned flights identical with "Conquest," and "Balanced" programs.
Space Applications			
Meteorology	An austere program with substantial risk that the basic objectives of the program will not be realized in an orderly fashion. Austerity of the program impacts overall basic meteorological research, national and international commitments, support for the Global Atmospheric Resea.ch Program, and support for ESSA. Achievement of long-range numerical forecasting not likely before late-1970's or 1980's.		
Earth Resources Survey	An austere program based on a limited commitment to development of a national ERS program. Many objectives deferred indefinitely.		

- Continued -

TABLE 6-3 (CONTINUED

PROGRAM	CONQUEST	BALANCED	RETURNS
Communications/ ATS	Substantial risk that program objectives will not be realized in an orderly fashion. Stretched ATS program delays communication experiments two years beyond optimum pace. Meteorological experiments likewise delayed. Minimal progress toward operational Community TV and Direct TV broadcast systems. Only "Returns" program includes TDRSS.		
Navigation/ Traffic Control	An austere program. Activity restricted to a small number of experimental tests on ATS and NIMBUS-type spacecraft. May not meet needs of SST's for accurate mid-ocean navigation.		
Geodesy	An austere program. No provision for development of advanced precision distance measurement techniques needed in many areas of research dealing with the dynamic Earth and the oceans. GEOS C flight delayed one year in "Conquest" program.		

TABLE 6-4

PROGRAMMATIC FACTORS - $3.8 B/YR FUNDING LEVEL

FACTOR	CONQUEST OF SPACE	BALANCED	RETURNS OF SPACE ACTIVITY
Funding Pattern	• At $3.8 B level in FY70. Dip to $3.6 B in FY71 caused by previous lack of new starts. Rise to $4.5 B level in FY73 attributable principally to selection of production rate of 2/yr for Saturn V and associated spacecraft.	• At $3.8 B level in FY70. Dip to $3.5 B in FY71 caused by previous lack of new starts. Rise to $4.6 B level in FY73 attributable principally to selection of production rate of 2/yr for Saturn V and associated spacecraft.	• Same as "Conquest," except rise held to $4 B level by curtailment of Lunar Exploration program.
Sensitivity to Budget Cut ($300M in FY70)	• Would require deemphasis of manned lunar exploration including termination of Saturn V, reduction of early manned astronomy, and slip in science and applications programs. • Further cuts in funding would probably invalidate this strategy.	• Would require deemphasis of manned lunar exploration, including termination of Saturn V, reduction of early manned astronomy, and slip in science and applications programs. • Further cuts in funding would cause this strategy to evolve to a "Returns" strategy.	• Would require curtailment of lunar exploration and slip in science and applications programs. • Further cuts in funding could be accommodated since there is no commitment to a major program.
Sensitivity to Budget Increase ($300M in FY70)	• Would provide increased confidence in success of EMSF and planetary exploration missions and minor increases in science and technology programs.	• Would provide increased support for all programs.	• Would probably require change in strategy to accommodate further increase in funding.
Sensitivity to Project/Mission Failure	• Emphasis on manned experiments, including ATM, makes disciplinary programs strongly dependent on EMSF success. • Operational capability of 210 foot dish impacts planetary spacecraft design. • Failure of planetary Mars missions could affect selection of next major NASA objective.	• Disciplinary programs moderately dependent on EMSF success. • Operational capability of 210 foot dish impacts planetary spacecraft design.	• Disciplinary programs moderately dependent on EMSF success. • Operational capability of 210 foot dish impacts planetary spacecraft design. • Unmanned programs have backup in many areas.
Sensitivity to Unanticipated Gain in Knowledge	• Further evaluation of man-in-space and the space environment could result in requirement for new design approaches.	• Discovery of extra-terrestrial life by Planetary program could cause reassessment of category emphasis. • Same as "Conquest."	• Discovery of extra-terrestrial life by Planetary program cannot be readily exploited with manned planetary missions. • Important discoveries on manned Lunar Exploration flight may dictate continuance of the program in a manned mode. • Same as "Conquest."
Sensitivity to USSR Achievement	• Program has potential for achieving "firsts." • Unanticipated willingness of USSR to participate in international cooperative efforts in Applications programs probably cannot be accommodated.	• Limited potential for achieving "firsts." • Unanticipated willingness of USSR to participate in international cooperative efforts in Applications programs probably cannot be accommodated.	• Space "spectacular" by USSR may be difficult to match or better once Saturn V has been deferred. • Could support international cooperative efforts in Applications programs. • Considerable support to many agencies.
Support to Other Agencies	• Applications program provides minimal support to Global Atmospheric Research Program. • Space Physics program supports some international cooperative efforts.	• Same as "Conquest."	• Space Physics program supports some international cooperative efforts.
Maintenance of Scientific, Technical, and Administrative Base	• Nuclear Rockets reduced to SRT level. • Unmanned Space Biology program is dead-ended.	• Manned astronomy past ATM-A is not supported. • Nuclear Rockets reduced to SRT level.	• Production of Saturn V deferred after AS 515. • Nuclear Rockets reduced to SRT level.
Continuity of Space Activity	• Three year gap between AAP and EOSL first launch activity. • Unmanned Space Biology program is dead-ended.	• Three year gap between AAP and EOSL first launch activity. • Lunar program gapped in 1972.	• Two year gap between AAP and EOSL first launch activity. • [illegible]

Space Activity	activity. • Unmanned Space Biology program is dead-ended. • High frequency of [illegible]tary missions requires flexible spacecraft design for modular payloads. • Lunar program gapped in 1972.	activity. • Lunar program gapped in 1972.	activity. • High frequency of science and applications missions requires flexible spacecraft design for modular payloads. Lunar program gapped in 1972, manned program terminated in 1975.
Growth Potential	• Provides potential for selection from future options of long duration manned earth orbital, manned planetary, manned astronomical observatory, or lunar base missions in early to mid '70's.	• Same as "Conquest," but delays decision point on future manned options to the mid to late '70's.	• Limited potential for future options. Generally restricted to manned earth orbital and unmanned lunar, planetary, and deep space missions in the 1970's after the Apollo runout. Decision point on future manned options deferred to late '70's or early '80's.
New Starts - FY70	• EMSF experiments • EOSL program definition • Lunar exploration option definition • Planetary SRT • '72 Venus Explorer • '73 Mercury/Venus Swingby • '73 Venus Flyby (probes) • OSO (I-K) • Astronomy explorers • Airplane observatory • Aircraft Technology • Advanced Space Technology • Space Applications SRT • GEOS C • 210 foot dish (DSN)	• EMSF experiments • EOSL program definition • Lunar exploration option definition • Planetary SRT • '72 Venus Explorer • '73 Mercury/Venus Swingby • OSO (I-K) • Astronomy Explorers • Airplane observatory • Atmospheric Explorers • SSS • Biosatellites (G-I) • Bio Pioneer (A-B) • Aircraft Technology • Advanced Space Technology • Space Applications SRT • GEOS C • 210 foot dish (DSN)	• EMSF experiments • EOSL program definition • Lunar exploration option definition • Planetary SRT • '72 Venus Explorer • '73 Mercury/Venus Swingby • OSO (I-K) • Astronomy Explorers • Airplane observatory • Atmospheric Explorers • SSS • Biosatellites (G-I) • Bio Pioneer (A-B) • Aircraft Technology • Advanced Space Technology • Space Applications SRT • Synchronous Meteorological Satellites • ERS A/C • ERS Limited Objectives (A-B) • ERTS (A-B) • GEOS (C-D) • WWW • 210 foot dish (DSN)
New Starts - FY71	• Maintenance of Saturn Apollo capability • INT-21, Saturn IB procurement • EOSL and experiment modules • New logistics spacecraft • Extended Apollo • Planetary SRT • '73 Mars Mariner orbiter • '75 Mars Orbiter/lander • '73 Venus Explorer • Astronomy sounding rockets • OAO (D-E) • Atmospheric Explorers • SSS • Aircraft Technology • Advanced Space Technology • Space Applications SRT • Synchronous Meteorological Satellites • ERS Limited Objectives (A-B) • ERS A/C • ERTS (A-B) • WWW	• Maintenance of Saturn Apollo capability • INT-21, Saturn IB procurement • EOSL and experiment modules • New logistics spacecraft • Extended Apollo • Lunar automated orbiter • Lunar automated surface vehicle • Planetary SRT • '73 Mars Explorer • '73 Venus Explorer • Astronomy sounding rockets • OAO (D-E) • Aircraft Technology • Advanced Space Technology • Space Applications SRT • Synchronous Meteorological Satellites • ERS Limited Objectives (A-B) • ERS A/C • ERTS (A-B) • WWW	• Maintenance of Saturn Apollo capability • Saturn IB procurement • EOSL module • Extended Apollo • Lunar automated orbiter • Lunar automated surface vehicle • Planetary SRT • '73 Mars Explorer • '73 Venus Explorer • Astronomy sounding rockets • OAO (D-E) • Aircraft Technology • Advanced Space Technology • Space Applications SRT • TIROS • ATS (H-J) • TDRSS

TABLE 6-2

PROGRAMMATIC FACTORS - $4.1 B/YR FUNDING LEVEL

FACTOR	CONQUEST OF SPACE	BALANCED	RETURNS OF SPACE ACTIVITY
Funding Pattern	• At $4.1 B level in FY70. Dip to $3.8 B in FY71 caused by previous lack of new starts. Rise to $4.8 B level in FY73/74 could be prevented by curtailing Lunar Exploration and by cuts in science and applications (except Planetary) programs after FY70.	• At $4.1 B level in FY70. Dip in FY71 avoided because of more aggressive Lunar Exploration program. Rise to $5 B level in FY73/74 could be prevented by adopting more modest programs in all categories after FY70.	• Same as "Balanced."
Sensitivity to Project/Mission Failure	• Emphasis on manned experiments, including ATM, makes disciplinary programs strongly dependent on EMSF success. • Operational capability of 210 foot dish impacts planetary spacecraft design. • Failure of planetary Mars missions could affect selection of next major NASA objective.	• Same as "Conquest." • Unmanned programs have backup in many areas.	• Same as "Balanced."
Sensitivity to Unanticipated Gain in Knowledge	• Further evaluation of man-in-space and the space environment could result in requirement for new design approaches.	• Discovery of extra-terrestrial life by Planetary program could cause reassessment of category emphasis.	• Same as "Balanced."
Sensitivity to USSR Achievement	• Program has potential for achieving "firsts." • Unanticipated willingness of USSR to participate in international cooperative efforts in Applications programs probably cannot be accommodated.	• Program has potential for achieving "firsts." • Could support international cooperative efforts in Applications programs.	• Same as "Balanced."
Support to Other Agencies	• Applications program provides minimal support to Global Atmospheric Research Program. • Space Physics program supports some international cooperative efforts.	• Considerable support to many agencies. • Space Physics program supports many international cooperative efforts.	• Same as "Balanced."
Maintenance of Scientific, Technical, and Administrative Base	• No significant discontinuities.	Same as "Conquest."	• Same as "Conquest."
Continuity of Space Activity	• Three year gap between AAP and EOSL first launch activity. • High frequency of planetary missions requires flexible spacecraft design for modular payloads. • Lunar program gapped in 1972.	• Three year gap between AAP and EOSL first launch activity. • High frequency of science and applications missions requires flexible spacecraft design for modular payloads.	• Same as "Balanced," except two year gap between AAP and EOSL first launch activity.
Growth Potential	• Provides potential for selection from future options of long duration manned earth orbital, manned planetary, manned astronomical observatory, or lunar base missions in early to mid '70's.	• Same as "Conquest," but delays decision point on future manned options to the mid '70's.	• Same as "Balanced."
New Starts - FY70	• Supporting Development • Augmented AAP • EMSF experiments • EOSL program definition • Lunar exploration option definition • Planetary SRT • '72 Venus Explorer • '73 Venus Flyby (probes) • '73 Mercury/Venus Swingby • Astronomy sounding rockets • OSO (I-K) • OAO (D-E) • Astronomy Explorers • Airplane observatory • Atmospheric Explorers • [illegible]	• EMSF experiments • EOSL program definition • Lunar exploration option definition • Extended Apollo • Lunar automated orbiter • Lunar automated surface vehicle • Planetary SRT • '73 Venus Flyby (probes) • '72 Venus Explorer • '73 Mercury/Venus Swingby • Astronomy sounding rockets • OSO (I-K) • OAO (D-E) • Astronomy Explorers • Airplane observatory • Atmospheric Explorers • [illegible]	• EMSF experiments • EOSL program definition • Lunar exploration option definition • Extended Apollo • Lunar automated orbiter • Lunar automated surface vehicle • Planetary SRT • '72 Venus Explorer • '73 Mercury/Venus Swingby • Astronomy sounding rockets • OSO (I-K) • OAO (D-E) • Astronomy Explorers • Airplane observatory • Atmospheric Explorers • [illegible] • [illegible]

	· '73 Venus Flyby (probes) · '73 Mercury/Venus Swingby · Astronomy sounding rockets · OSO (I-K) · OAO (D-E) · Astronomy Explorers · Airplane observatory · Atmospheric Explorers · SSS · Biosatellite (G-I) · Bio Pioneer (A-B) · Aircraft Technology · Advanced Space Technology · Space Applications SRT · 210 foot dish (DSN)	· '73 Venus Flyby (probes) · '72 Venus Explorer · '73 Mercury/Venus Swingby · Astronomy sounding rockets · OSO (I-K) · OAO (D-E) · Astronomy Explorers · Airplane observatory · Atmospheric Explorers · SSS · Space Physics Laboratory · Biosatellites (G-H) · Improved Biosatellites (A-F) · Bio Pioneer (A-B) · Bio Explorer (A-B) · Aircraft Technology · Advanced Space Technology · Space Applications SRT · Synchronous Meteorological Satellites · ERS A/C · ERTS (A-B) · ERS Limited Objectives (A-B) · ATS (H-J) · TDRSS · GEOS (C-D) · WWW · 210 foot dish (DSN)	· '72 Venus Explorer · '73 Mercury/Venus Swingby · Astronomy sounding rockets · OSO (I-K) · OAO (D-E) · Astronomy Explorers · Airplane observatory · Atmospheric Explorers · SSS · Space Physics Laboratory · Biosatellites (G-H) · Improved Biosatellites (A-F) · Bio Pioneer (A-B) · Bio Explorer (A-B) · Aircraft Technology · Advanced Space Technology · Space Applications SRT · Synchronous Meteorological Satellites · ERS A/C · ERTS (A-B) · ERS Limited Objectives (A-B) · ATS (H-J) · TDRSS · Broadcast TV · Navigation/Traffic Control · GEOS (C-D) · WWW · TIROS Follow-On · 210 foot dish (DSN)
New Starts - FY71	· Maintenance of Saturn Apollo capability · INT-21, Saturn IB procurement · EOSL and experiment modules · New logistics spacecraft · Extended Apollo · Planetary SRT · '73 Mars Mariner orbiter · '75 Mars Orbiter/lander · '73 Venus Explorer · ASTRA · Aircraft Technology · Advanced Space Technology · Space Applications SRT · Synchronous Meteorological Satellites · WWW · ERS A/C · ERS Limited Objectives (A-B) · ERTS (A-E) · TDRSS	· Maintenance of Saturn Apollo capability · INT-21, Saturn IB procurement · EOSL and experiment modules · New logistics spacecraft · Lunar Saturn V, CSM, LM procurement · Planetary SRT · '73 Mars Explorer · '75 Mars rough lander · '73 Venus Explorer · '74 Jupiter Flyby · IMP · Aircraft Technology · Advanced Space Technology · Space Applications SRT · Nimbus (G-H) · TIROS · Direct TV	· Maintenance of Saturn Apollo capability · Saturn IB procurement · EOSL module · Lunar Saturn V, CSM, LM, procurement · Planetary SRT · '73 Mars Explorer · '75 Mars rough lander · '73 Venus Explorer · '74 Jupiter Flyby · IMP · Aircraft Technology · Advanced Space Technology · Space Applications SRT · Nimbus (G-H) · ATS Meteorology · ERS R&E · ERS Limited Objectives (C-D) · Direct TV

TABLE 6-6

PROGRAMMATIC FACTORS - $3.5 B/YR FUNDING LEVEL

FACTOR	CONQUEST OF SPACE	BALANCED	RETURNS OF SPACE ACTIVITY
Funding Pattern	• At $3.5 B/yr level in FY70 with rise to $3.7 B.	• Same as "Conquest."	• Same as "Conquest."
Sensitivity to Project/Mission Failure	• Reduction in unmanned science and applications forces reliance on experiments that are on-board EMSF missions. • Operational capability of 210 foot dish impacts planetary spacecraft design. • Little backup in most areas.	• Disciplinary programs moderately dependent on EMSF success. • Operational capability of 210 foot dish impacts planetary spacecraft design.	• Same as "Balanced."
Sensitivity to Unanticipated Gain in Knowledge	• Further evaluation of man-in-space and the space environment could result in requirement for new design approaches. • Discovery of extra-terrestrial life by Planetary program cannot be readily exploited with manned planetary missions. • Important discoveries on manned Lunar Exploration flight may dictate continuance of the program in a manned mode.	• Same as "Conquest."	• Same as "Conquest."
Sensitivity to USSR Achievement	• Limited potential for achieving "firsts." • Unanticipated willingness of USSR to participate in international cooperative efforts in Applications programs probably cannot be accommodated. • Space "spectacular" by USSR may be difficult to match or better once Saturn V has been terminated.	• Same as "Conquest."	• Space "spectacular" by USSR may be difficult to match or better once Saturn V has been terminated. • Could support international cooperative efforts in Applications programs.
Support to Other Agencies	• Applications program provides minimal support to Global Atmospheric Research Program. • Space Physics program supports some international cooperative efforts.	• Same as "Conquest."	• Same as "Conquest."
Maintenance of Scientific, Technical, and Administrative Base	• Nuclear Rocket program canceled. • Unmanned Space Biology program dead-ended. • No automated lunar program. • Saturn V production deferred after AS 515. • SA 213, 214 canceled. • Manned astronomy not supported.	• Manned astronomy not supported. • Nuclear Rocket program canceled. • Saturn V production deferred after AS 515. • No automated lunar program. • Unmanned Space Biology program dead-ended.	• Manned astronomy past ATM-A not supported. • Nuclear Rocket program canceled. • Saturn V production deferred after AS 513. • No automated lunar program.
Continuity of Space Activity	• Three year gap between AAP and EOSL first launch activity. • Unmanned Space Biology program is dead-ended. • No lunar program after 1973.	• Same as "Conquest."	• Two year gap between AAP and EOSL first launch activity. • No lunar program after 1973.
Growth Potential	• Limited potential for future options. Generally restricted to manned earth orbital and unmanned lunar, planetary, and deep space missions. Decision	• Same as "Conquest."	• Same as "Conquest."

Growth Potential	• Limited potential for future options. Generally restricted to manned earth orbital and unmanned lunar, planetary, and deep space missions. Decision point on future manned options deferred until late '70's.	• Same as "Conquest."	• Same as "Conquest."
Cancellations - FY69	• SA 213/214 • Saturn V beyond AS 515 • ATM • '71/'72 Biosatellite • NERVA • Sunblazer, Sunblazer Array	• SA 213/214 • Saturn V beyond AS 515 • ATM • '71/'72 Biosatellite • NERVA	• Saturn V beyond AS 513 • NERVA
New Starts - FY70	• EMSF experiments • EOSL program definition • Lunar exploration option definition • '72 Venus Explorer • '73 Mercury/Venus Swingby • OSO (I-K) • Astronomy Explorers • Airplane observatory • Space Applications SRT • 210 foot dish (DSN)	• EMSF experiments • EOSL program definition • Lunar exploration option definition • '72 Venus Explorer • '73 Mercury/Venus Swingby • OSO (I-K) • Astronomy Explorers • Airplane observatory • Space Applications SRT • 210 foot dish (DSN) • GEOS C	• EMSF experments • EOSL program definition • Lunar exploration option definition • Planetary SRT • '72 Venus Explorer • '73 Mercury/Venus Swingby • OSO (I-K) • Astronomy Explorers • Airplane observatory • Biosatellite (G-I) • Bio Pioneer (A-B) • Space Applications SRT • ERS A/C • ERS Limited Objectives (A-B) • ERTS (A-B) • GEOS C • 210 foot dish (DSN)
New Starts - FY71	• Maintenance of Saturn Apollo capability • Saturn IB procurement • EOSL and experiment modules • New logistics spacecraft • Extended Apollo • Planetary SRT • '73 Mars Explorer • '73 Mars Orbiter • '73 Venus Explorer • Astronomy sounding rockets • OAO (D-E) • Atmospheric Explorers • SSS • Aircraft Technology • Advanced Space Technology • Space Applications SRT • Synchronous Meteorological Satellites • WWW • ERS A/C • ERS Limited Objectives (A-B) • ERTS (A-B) • GEOS C	• Maintenance of Saturn Apollo capability • Saturn IB procurement • EOSL and experiment modules • New logistics spacecraft • Extended Apollo • Planetary SRT • '73 Mars Explorer • '73 Venus Explorer • Astronomy sounding rockets • OAO (D-E) • Atmospheric Explorers • SSS • Aircraft Technology • Advanced Space Technology • Synchronous Meteorological Satellites • WWW • ERS A/C • ERS Limited Objectives (A-B) • ERTS (A-B)	• Maintenance of Saturn Apollo capability • Saturn IB procurement • EOSL module • Extended Apollo • Planetary SRT • '73 Mars Explorer • '73 Venus Explorer • Astronomy sounding rockets • OAO (D-E) • Atmospheric Explorers • SSS • Aircraft Technology • Advanced Space Technology • Space Applications SRT • Synchronous Meteorological Satellites • WWW • ATS (H-J) • TDRSS

Chapter 7

SPECIAL STUDIES

7.0 Introduction

This chapter identifies and summarizes special studies which were carried out and formally documented by Bellcomm in direct support of NASA Planning System activities to develop the NASA FY70 Program.

7.1 Study Summary

Appendix III contains a study of the costing methodologies used by the Program Category Working Groups in developing their Program Memoranda. The methodology used by each Working Group and the cost omissions that were detected in the study are shown in Figure 7-1. The approaches can be classified as follows:

- Where proposed projects were similar to past or existing designs, historical data was projected considering changes in the design concept. This methodology was extensively used by the OSSA personnel.

- Where little historical base exists (in particular, Extension of Manned Space Flight) lump-sum estimates were made, at the module level, by cost analysts at the Centers in conjunction with conceptual design engineers. As such, these should correspond to those obtainable at the conclusion of a Phase A study.

- Where the major elements of costs were modifications to existing designs or hardware elements which had been extensively studied, cost estimates were based on manpower estimates of likely candidate contractors. This was used by the Lunar Exploration Working Group.

- The Space Biology Working Group developed a unique methodology to account for the wide variation in experiment packages and the high attrition rate of originally proposed (and funded) experiments.

The review revealed that in the preparation and reporting of cost estimates:

- No distinction between costs and obligations was made,

- The handling of inflationary effects was not uniform among the Program Categories, and

- There was no indication as to whether the estimates were based on in-house integration or integration by a prime contractor.

PROGRAM CATEGORY	SUMMARY OF COSTING METHODOLOGIES	OMISSIONS
EMSF	APOLLO INVENTORY EQUIPMENT: APOLLO COST STUDY LAUNCH AND MISSION OPERATIONS: APOLLO COST STUDY NEW DEVELOPMENTS: ESTIMATE OF COST ANALYSTS AT CENTERS EXPERIMENTS: ESTIMATE BY ENGINEERING PERSONNEL	UNCERTAIN
LUNAR EXPLORATION	NASA ESTIMATES OF LIKELY CONTRACTOR'S TIME-PHASED MANPOWER REQUIREMENTS CONVERTED TO DOLLARS.	LAUNCH VEHICLES LAUNCH OPERATIONS MISSION OPERATIONS
PLANETARY EXPLORATION	ESTIMATES MADE BY CENTER WHICH WAS ASSUMED WILL BE RESPONSIBLE FOR PROJECT WITH HQ REVIEW	POSSIBLE INCREASE IN MISSION OPERATIONS COST DUE TO OVERLAPPING PROJECTS.
ASTRONOMY	EXTRAPOLATIONS ON A SUBSYSTEM LEVEL OF PAST EXPERIENCE FOR SIMILAR EFFORTS AND ON CONTRACTOR STUDIES FOR NEW DESIGNS.	—
SPACE APPLICATIONS	EXTRAPOLATIONS OF COSTS OF EXISTING DESIGNS	LAUNCH VEHICLE COSTS
SPACE PHYSICS	EXTRAPOLATIONS OF COSTS OF EXISTING DESIGNS AND CENTER IN-HOUSE STUDIES	—
SPACE BIOLOGY	EXPERIMENTS: UNIQUE TIME-PHASING OF EXPERIMENT PACKAGES BASED ON HISTORY OF EXPERIMENT ATTRITION AND COSTS SPACECRAFT: EXTRAPOLATION FROM EXISTING DESIGNS.	—
ADVANCED SPACE TECHNOLOGY	LEVEL OF EFFORT TO ACCOMPLISH SETS OF R&D OBJECTIVES	—
SUPPORTING ACTIVITIES (T & DA)	OPERATIONS COSTS OF EACH STATION FOR THREE MISSION MODELS. COSTS BASED ON NUMBER OF TELEMETRY LINKS, MAN-SHIFTS REQUIRED AND HISTORICAL RECORD OF COSTS OF EACH STATION.	OPERATIONS COSTS OF DOMESTIC STATIONS AND NASCOM.

FIGURE 7-1 SUMMARY OF COSTING METHODOLOGIES

Chapter 8
PSG/PCG Meetings

Chapter 8

MEETINGS OF PLANNING STEERING AND PLANNING COORDINATION GROUPS

8.0 Identification of Meetings

During the period from January, 1968, to October 15, 1968, the Planning Steering and Planning Coordination Groups held meetings on the dates indicated:

PSG	PCG
February 20	February 26, 29
March 5, 6	March 6, 13, 22
April 25, 26	April 1, 9
May 23	May 8, 9, 16, 21, 28
June 19	June 4, 11, 18
July 23-24	July 2, 9, 30
September 3-4	August 14
	September 10

8.1 Minutes of Meetings

The minutes of the PSG meetings are contained in Appendix IV; of the PCG, in Appendix V. The events of the PCG meetings of May 21 and May 28 were not formally documented with minutes. The minutes of the PCG meeting of September 10 are in effect the minutes of the PSG meeting of September 3-4.

Appendix I
Projects/Missions

APPENDIX I

DESCRIPTION OF PROJECTS AND MISSIONS

APPENDIX I

Project/Mission	Description
Extension of Manned Space Flight Capability	
AAP	The Apollo Applications Program is a manned space flight program, capitalizing on the capability developed during Gemini and Apollo, designed to take a number of essential early steps toward the long term objectives of the Manned Space Flight Program. AAP relies primarily on equipment and facilities made available by the Apollo program; major system elements are the Saturn I Workshop, the ATM, and the Saturn IB launch vehicle.
Earth Orbital Space Laboratory	The Earth Orbital Space Laboratory is in the process of being defined, and various concepts are being considered, ranging from an assembly of small modules to a large integral device containing all of the required functions. It is to provide the focus for the evolution of long duration systems, having a two year operational lifetime, accommodating three to nine crew members, with resupply taking place at three to six month intervals. It is to stress mission and operational flexibility and be compatible with several different launch vehicles.
Saturn I Workshop	The Saturn I Workshop comprises the S-IV B stage of the Saturn IB launch vehicle, an airlock module/multiple docking adapter, and a modified Apollo Command Module. The spent S-IV B stage forms the nucleus of a 3-man space vehicle with a 10,000 cubic foot volume for conducting exploratory space station operations and technological/scientific experiments. Crew, power, life support, thermal, communication, and experiment subsystems, together with provisions for docking the CM, occupy the volume normally occupied by the Lunar Module in the nominal Apollo configuration. In the first mission, the duration will be open-ended to 28 days. Later missions with durations up to 56 days are being planned.
Lunar Exploration	
Advanced Orbiter	The Advanced Orbiter is an improved version of the Lunar Orbiter designed to support manned landings with high-resolution photography and remote sensing for site selection, science planning, and lunar-wide surveys. It is injected into a translunar trajectory by an Atlas/Centaur launch vehicle.

...t/Mission	Description
...ated Surface ...les	This system consists of an intermediate launch vehicle of the Titan III/Centaur or Saturn IB/Centaur class and an Advanced Surveyor-type spacecraft designed to deliver a Dual Mode Rover, Remote Geophysical Monitors and a Science Station to the lunar surface. The Science Station is placed in operation at the landing point, while the Dual Mode Rovers are to rendezvous with manned landings at the end of their automated long-range traverses. This provides for the return of samples collected during the traverse as well as being an aid to astronaut mobility. During each long-range traverse, long-lived seismic observatories are deployed along the route.
...l Launch	Dual launch missions include an automated version of the LM (Lunar Payload Module - LPM) landed prior to the arrival of the astronauts in an Extended LM. The CSM which delivers the LPM to the Moon stays in lunar orbit and conducts high resolution photography, metric mapping, remote sensing, or deploys a sub-satellite. The surface mission increases astronaut staytime to 7-12 days.
...tended Apollo	The Extended Apollo system is a modified and somewhat upgraded Apollo system designed for longer stay times, greater mobility, and improved scientific investigation capability on the lunar surface. The system consists of an extended LM; a CSM with improved scientific instrumentation; two Lunar Flying Units per mission; an improved EVA suit; the Advanced ALSEP; an Apollo Drill, and upgraded sample return capability.

...etary Exploration

...eroid Mariner ...by (1974, 76)	The spacecraft is a modified Mariner '69 (see Mercury Mariner Flyby) to the asteroids Vesta (74) and Ceres (76). Trip times are about one year. TV imagery will provide measurements of the asteroids' size, shape, surface characteristics, and rotational properties.
...et Mariner ... (1974, 76)	The spacecraft is a modified Mariner '69 (see Mercury Mariner Flyby) to the comets Enke (74) and D'Arrest (76). Trip times are approximately three months and experiments provide TV imagery of comet structure, as well as remote sensing of composition and comet environment. Launch vehicle is a Titan III/Centaur.

Project/Mission	Description
Mars Explorer Orbiter (1972-75)	Explorer class spacecraft have been developed and extensively flown as unmanned scientific Earth satellites. Configurations vary widely. Generally, the spacecraft is drum-shaped, varying in diameter from 3 to 5 feet, and is approximately 3 feet high. The spacecraft is in the 250-lb weight class and with a kick stage added (Burner II or TE-364), the weight is approximately 500 lbs. The launch vehicle is an Atlas/Centaur. The 1973 mission will make measurements of the Mars environment. After one year, the mission will terminate in orbital decay to permit ionospheric and atmospheric measurements.
Mars Mariner Orbiter (1971)	Mariner is a developed spacecraft system designed to explore planets between 0.4 and 2 AU in a flyby or orbiter mode, which can deploy instrumented probes for obtaining data on planetary atmospheres. Mission flight times are less than one year and communication distances are less than 1.7 AU. The spacecraft is fully stabilized, uses a solar-cell power system, is equipped to perform two midcourse guidance maneuvers, has on-board tracking capability, and weighs 1000-2000 lbs. The launch vehicle is an Atlas/Centaur. In the 1971 Orbiter mission, two spacecraft will be placed in high and low inclination orbits around Mars to enable the mapping of at least 70% of the surface (high) and to permit optimum viewing of the darkening wave (low). Minimum orbital lifetime is 90 days.
Mars Mariner Orbiter (1973)	See Mars Mariner Orbiter 1971. The 1973 mission opportunity provides better conditions for mapping the northern hemisphere than the 1971 opportunity. The 1973 Orbiter complements the 1973 Mars lander (see below). Titan III C is a possible launch vehicle.
Mars Orbiter-Hard Lander (1973-77)	The spacecraft is a modified Mariner '71 Orbiter with an 800-lb direct-entry landing capsule. The orbiter provides a data-relay link to Earth. The lander will perform imagery and minimum life detection experiments. The design surface life is one week. Titan III C is a candidate launch vehicle.
Mars Soft Lander (Small, 1975-77)	The spacecraft is a modified Mariner '71 Orbiter. The science payload is essentially the same as that of the '73-'77 hard lander but offers significant growth potential. The emphasis is on biological experiments. The design surface life is one week. The launch vehicle is a Titan III-C/Centaur.

Project/Mission	Description
Mars Soft Lander (Medium, 1977)	The spacecraft is a modified Mariner '71 Orbiter. The payload emphasizes biological measurements with a comprehensive approach to the analysis of life forms and accomplishes the objectives of the first Voyager mission. The design surface life is three months (using a solar power system). The launch vehicle is a Titan III/Centaur.
Mercury Mariner Flyby (1973, 75)	The spacecraft is a Modified '69 Mariner (Mariner F & G to Mars). The spacecraft weight is 800-900 lbs. The mission utilizes a gravity swingby maneuver at Venus to reduce launch vehicle energy requirements. The experiments provide for TV observations and surface/atmospheric measurements of Mercury. After 1975 the next swingby opportunity occurs in 1981. Launch vehicle is an Atlas/Centaur.
Multiple Outer Planet Flyby (1977, 78) "Grand Tour"	The spacecraft is of the Improved Mariner class modified as indicated by information obtained from the 1974 Jupiter flyby. The mission capitalizes on the unique alignment of Jupiter, Saturn, Uranus, and Neptune that permits a "grand tour" of these planets with one spacecraft by utilizing gravity swingby maneuvers at each planet. The next such opportunity after 1978 will be in 2157. Experiments are of the IMP type during the interplanetary portions of the mission (out to 30 AU) and TV imaging and radio occultation at the planets. The launch vehicle is a Titan III/Centaur/Burner II.
Jupiter Flyby (1974)	Improved Mariner class spacecraft for making TV observations of Jupiter. Flight profile continues out to 10 AU to provide design information for the "Grand Tour" mission described above. Launch vehicle is a Titan III/Centaur with a Burner II kick stage.
Jupiter Pioneer Flyby (1972, 73)	See Venus Pioneer E Orbiter for spacecraft description. The experiments will permit early assessment of the asteroid belt beyond Mars and provide measurements of the Jupiter environment. Launch vehicle is an Atlas/Centaur with a TE-364 kick stage.
Venus Explorer Orbiter (1972-75)	See Mars Explorer Orbiter. Launch vehicle is a Thrust Augmented Delta with a TE-364 kick stage.
Venus Mariner Flyby Atmospheric Probe (1973, 75)	See Mars Mariner Orbiter (1971) for spacecraft description. Spacecraft deorbits 25-lb probes to investigate atmospheric composition, temperature, and pressure profiles. The 1975 mission offers the option of using a Buoyant Venus Station for extended measurements. The launch vehicle is an Atlas/Centaur.

Project/Mission	Description
Venus Mariner Orbiter Hard Lander (1975)	Modified Mars Mariner Orbiter (71). Experiments include atmospheric measurements during descent and physical environment surface measurements concentrating on composition, state, and life support potential. Surface life is a few hours. Launch vehicle is a Titan III C or an Atlas/Centaur.
Venus Mariner Orbiter (1976)	Modified Mariner '71 Orbiter with a 90-day minimum design life for obtaining high resolution radar maps of Venus. Launch vehicle is an Atlas/Centaur.
Venus Pioneer E Orbiter (1970)	The spacecraft is a modified Pioneer E, with a diameter of approximately 4 feet and a height of about 8 feet. Spacecraft weight is about 150 lbs; it is spin-stabilized and solar-cell powered. The experiments will measure particles and fields during the interplanetary flight, afford an opportunity for extended observations in the vicinity of Venus, and serve as an interplanetary monitoring platform (IMP) at 0.7 AU. Its design life is 7-8 months. The launch vehicle is an Atlas with a Burner II kick stage, or a Thrust Augmented Delta with a TE-364 kick stage.
Astronomy	
Airplane Observatory	The Airplane Observatory is a 36-inch telescope mounted on an aircraft capable of sustained flight at altitudes in excess of 40,000 feet. This instrument permits observations of infra-red emissions from planetary atmospheres, protostars, quasars, the sun and comets, normally blocked by the Earth's atmosphere.
ASTRA	The Astronomical Space Telescope Research Assembly is an evolution of the observatory class of spacecraft. The central element of ASTRA is a one-meter aperture diffraction-limited telescope. Details of this system are currently being defined. ASTRA instrumentation will provide diffraction-limited visible photography of significant galactic objects, clusters, double stars, and planets; observations of solar flares, sunspots, and coronal streamers. Resolution will be about 0.01 arc seconds.
ATM	The Apollo Telescope Mount is an assembly of astronomical instruments (white light coronagraph, X-ray flare telescope, X-ray spectroheliograph, UV spectrograph) that can be pointed and stabilized in any direction. The instrument "package" with its auxiliary

Project/Mission	Description
ATM (Continued)	equipment (supporting structure, control system, power system, etc.) weighs about 16000 lbs. and is launched by a Saturn IB as part of the AAP program. The ATM instruments permit measurements, with a spatial resolution of 5 arc-seconds, of bright X-ray sources and detailed solar measurements in the 1500-10000 Å spectral range. Man is required for film loading and retrieval and to operate the instruments.
Explorer-Class SAS	The Explorer-class Small Astronomical Satellites are drum-shaped satellites weighing 20 to 330 pounds and varying from 12 to 40 inches in height and 18 to 30 inches in diameter. Most of the spacecraft are spin-stabilized and powered by battery/solar cell systems. Launch vehicle is the Scout. Depending on instrumentation, the SAS can measure galactic, stellar, solar, or planetary electromagnetic radiation in the X-ray, infra-red, ultraviolet, and radio regions of the spectrum. Cosmic ray experiments are also possible. Orbits range from Earth circular to highly elliptical, with perigees ranging from 250 km to 6000 km and apogees as high as 90,000 km. Inclinations for astronomy missions are generally in the 0-60° range.
Helios	Helios represents an improved OSO; it will be larger and provide the capability and flexibility required for larger instruments to conduct more sophisticated solar astronomy experiments. Final design parameters have not been developed.
NASO	The National Astronomical Space Observatory will have as its central element a 2-3 meter aperture, diffraction-limited telescope with resolution on the order of 0.01 arc seconds. The NASO instruments will provide large light gathering power and high angular resolution in wavelengths from the Lyman limit to the infra-red; permit high resolution measurements in the radio, X-ray, and gamma-ray regions of the spectrum; and permit high-resolution visible light photography of significant astronomical objects.
[illegible]	The Orbiting Astronomical Observatory is an octagonal cylinder 10 feet long and 7 feet across the flats, with a hollow central tube to contain a 110 x 40-inch cylindrical experiment. All-up weight is about 4000 lbs. The power system is a solar cell array/battery system generating about 400 watts. Launch vehicle is an Atlas/Centaur. The orbit is 430 nm circular, inclined approximately 35°. The experiments permit

Project/Mission	Description
OAO (Continued)	precise telescopic observations of the celestial sphere for study of galaxies, stars, nebulae, the interstellar and interplanetary medium, and planets in the ultra-violet spectral region normally obscured by the Earth's atmosphere.
OSO	The overall height of the Orbiting Solar Observatory is 38 inches and the maximum dimension across the deployed solar cell array is 92 inches (44 inches when launched). The average weight is approximately 600 lbs, and instrumentation permits measurements of solar gamma-ray, X-ray, and ultra-violet emissions; energetic particles; zodiacal light and gegenschein; and cosmic ultra-violet radiation. Orbit is 300 nm circular at a 33° inclination.
RAE-A	This Radio Astronomy Explorer is somewhat larger than the Explorer class spacecraft described above. It is a cylinder 36 inches in diameter and 31 inches long, capped by truncated cones, with four fixed solar paddles. The spacecraft has a dipole antenna 120 feet tip-to-tip and an "X" shaped antenna with four 750-foot elements. Power is provided by batteries and solar cells. Weight of the spacecraft is approximately 300 lbs, and with the apogee kick stage, about 600 lbs. The Launch vehicle is a Thrust Augmented Improved Delta. The experiment maps the galaxy with low resolution in the frequency range 50 kHz to 10 MHz and monitors burst radiation from the sun. Orbit is retrograde, 6000 km circular, with a 58° inclination.
Space Physics	
AE	The Atmospheric Explorer satellite configuration is being defined. Its estimated weight is 300-400 lbs. The instrumentation includes mass spectrometers, Langmuir probes, and low-energy particle detectors. The mission profile is an Earth orbit (130 x 1000 km) with the satellite carrying an on-board propulsion system for restoring the energy lost at this low perigee. Launch vehicles are of the Delta class.
GRS	The Geophysical Research Satellite is a spin-stabilized cylindrical spacecraft about 4 1/2 feet in diameter and 5 feet long, weighing less than 600 lbs. Power will be supplied by a body-mounted solar-cell/battery system. GRS orbits vary: (1) highly elliptical orbits with apogees out to 300,000 km inclined at 31°, (2) synchronous

Project/Mission	Description
GRS (Continued)	orbits, (3) polar orbits with apogees out to 100,000 km. The objective is to study the magnetosphere, the interplanetary medium, and the role of the Sun and the galaxy as a source of energetic radiation. Launch vehicle is a Thrust Augmented Delta.
IMP	The Interplanetary Monitoring Platform is an Explorer-class spin-stabilized spacecraft about 4 1/2 feet in diameter and 3 feet long weighing about 500 lbs. Power supply is a 25-watt solar-cell/battery system. Orbits are essentially equatorial at altitudes from synchronous to 40 Earth radii. Instrumentation can measure solar and galactic cosmic radiation, the solar plasma, energetic particles within the magnetosphere, and the interplanetary magnetic field. Launch vehicle is a Thrust Augmented Improved Delta.
ISIS	The International Satellite for Ionospheric Studies is an Explorer-class spacecraft about 4 feet in diameter and 3 feet long deploying two sets of antennas measuring 75 feet and 240 feet across the tips. Total weight is about 475 lbs. Power supply is a 100-watt solar-cell/battery system. A typical orbit is a 500 x 3000 km ellipse inclined at about 80°. Instrumentation includes a 0.7-20 MHz swept frequency sounder, a 6-fixed-frequency sounder, a VLF receiver, an energetic particle detector, a soft particle spectrometer, an ion mass spectrometer, an electrostatic probe, a 136/137 MHz beacon, and a cosmic noise receiver. Measurements determine the temperature, species, and spatial distribution of ions and free electrons over daily, seasonal, and solar cycles. Secondary objectives include VLF radio astronomy studies and plasma studies. Launch vehicle is a Thrust Augmented Improved Delta.
OGO	The Orbiting Geophysical Observatory comprises a main body (31 x 33 x 68 inches), two large (78 square feet) solar arrays, and six deployable booms. Fully deployed, the observatory measures 50 feet across the booms and weighs 900-1200 pounds. The solar cell/battery power system generates 560 watts. The launch vehicle is an Atlas/Agena for low-inclination orbits and a Thrust Augmented Thor-Agena for polar orbits. The two mission profiles are highly eccentric (280 km perigee, 150,000 km apogee) low-inclination (30°) orbits and polar orbits (250 x 1000 km). The instrumentation measures terrestrial and interplanetary magnetic fields, electric fields; thermal and energetic particles including trapped radiation, and solar and galactic cosmic rays; solar, galactic, and terrestrial electromagnetic emissions including gamma rays, X-rays, UV, low-frequency background noise, and high-frequency galactic emissions; neutral and ionic composition of the terrestrial atmosphere; aurora and airglow emissions.

Project/Mission	Description
Pioneer	The Pioneer is a spin-stabilized spacecraft 3-4 feet in diameter and about 8 feet high in the fully deployed configuration. Its weight ranges from 140-160 lbs, and it is powered by solar cells. Launch vehicle is a Thrust Augmented Improved Delta to heliocentric orbits ranging from 0.5 to 2 AU. Measurements will be made of energetic particles, magnetic fields, interplanetary plasmas, and interplanetary gas and dust, and the spacecraft will map the propagation of solar disturbances between 0.5 and 1.2 AU.
Relativity Satellite	The Relativity Satellite is a 600-1000 lb spacecraft in Earth synchronous orbit carrying a hydrogen-maser clock which will be compared with its twin in an Earth laboratory. Comparison of the differing clock rates in orbit and on the ground will provide a further test of general relativity. Launch vehicle is currently undefined, but will be in the Saturn IB/Titan III class.
Solar Probe	The Solar Probe is to be a 250 lb spacecraft in heliocentric orbit with perigees of 0.2 and 0.1 AU. Launch vehicle will be of the Atlas/Centaur class for the 0.2 AU mission and the Saturn IB/Centaur class for missions to 0.1 AU. The objective is to make measurements of the solar environment in the upper regions of the solar atmosphere.
SSS	The Small Scientific Satellite represents a class of small, relatively inexpensive Scout-launched Earth-orbiting Explorer satellites featuring maximum commonality and versatility, with emphasis on providing a flexible, quick response experiment platform. Examples of this class of satellite are ESRO, San Marco, and the German Research Satellite. For the most part they are in the 200-lb class and have eccentric Earth orbits with perigees of 200-300 km and apogees out to 2000 km.
Sunblazer	The Sunblazer satellites weigh 15-60 lbs and are launched into solar orbits from 0.4 to 1.0 AU by a 5-stage Scout. A typical Sunblazer weighs about 30 lbs and is about 2 feet in diameter and 2 feet long. The power supply uses solar cells augmented by solid state amplifiers for instantaneous peaks (500 watts for 100 ms). Instruments make measurements of the solar corona, magnetosphere, and solar proton events.

Project/Mission	Description
Biosatellite (and Follow-On Biosatellite) (Continued)	about 6 feet. The afterbody contains expendables, the control system, and the communication system. The reentry vehicle contains a 32-inch diameter recovery capsule. Gross weight is about 1000 lbs. Recovery is by air-snatch of the parachute-equipped recovery capsule after reentry. Launch vehicle is a Thrust Augmented Improved Delta for a 150-250 nm near-equatorial orbit. Experiments measure effects of weightlessness, radiation, and removal of the Earth's periodicities on insects, plants, and a variety of cellular systems. The spacecraft can accommodate a 15-pound primate.
Improved Biosatellite	This is a product-improved version of Biosatellite with duration capability extended to 60 days. A limited number of flights to 400-500 nm altitudes are anticipated.

Aircraft Technology

General Aviation	Research in features leading to improvements in the safety of aircraft operation, including collision avoidance systems, automatic systems to reduce pilot workload, and the establishment of operating limit controls to maintain aircraft within safe boundaries.
Hypersonic Aircraft	Research directed at determining the practicality of sustained flight at hypersonic speeds (Mach 6-10). The program is limited to fundamental problems in propulsion, structures, and aerodynamics, including the construction of an operating engine for ground test research.
Subsonic Aircraft	Research directed toward solving problems preventing full exploitation of subsonic jet aircraft. This includes work toward reducing engine noise levels, reducing landing speed, and improving low speed flight control to permit safe use of smaller airports.
Supersonic Aircraft	A research program aimed at realizing safe, efficient supersonic cruise flight for military and civil aircraft. Problems involve airframe-engine integration, inlet-engine-nozzle dynamics, new materials suitable for long operation at high temperatures, more efficient turbine design, and optimum use of avionics to assist the pilot in control of such complex aircraft.
V/STOL Aircraft	Conduct research in problem areas preventing exploitation of the full potential of V/STOL aircraft. This includes work on rotor and propeller design, stability augmentation systems, all-weather operation, noise reduction

Project/Mission	Description
V/STOL Aircraft (Continued)	techniques, new materials having high fatigue resistance to high oscillatory loads, and integrated systems research of concepts showing greatest promise for future development.

Advanced Space Technology

NERVA	The NERVA-1 is a nuclear reactor rocket engine generating about 75,000 lbs of thrust. The hydrogen propellant flows at 90 lbs/sec and is first used to regeneratively cool the exhaust nozzle after which it is heated to 4500° R by a 1500 Mw uranium loaded, graphite-core reactor and expelled through the nozzle. Hot gas is bled from the exhaust to drive the turbo-machinery.
Otolith	The purpose of this experiment is to make a direct recording of the otolith responses in the weightless state. The stimulus is applied during flights by angular accelerations (on the order of 0.3 g) of a simple capsule. The capsule comprises a double container. The inner container is a spheroid and the outer container a sphere of approximately 11 inches diameter. Two frogs weighing about one lb each are placed head to tail in the inner container and their heads are fixed in a special holding device that assures a firm grip in flight. The body of each frog is supported by a nylon tubular net loosely connected with the main body of the capsule. The holding device can be rotated and tilted as required. The inner container rotates around a diametral axis while the outer container is fixed to the spacecraft.
SERT II	The SERT II program is to provide a long-term evaluation of the performance and reliability of electric ion thruster systems while subjected to the environment of space. The spacecraft will be launched into a 930-km, full sun orbit. The spacecraft structure is a cylinder 21 inches high and 59 inches in outside diameter, yielding a total available volume of approximately 33 cubic feet. Three-axis attitude control is achieved by gravity-gradient stabilization of two axes and the use of control moment gyros to stabilize the third axis. The gyros damp motion about all axes. Two backup cold gas control systems provide redundancy and reacquisition capability. Power for the spacecraft and the Agena is supplied by solar cells in panels arrayed from the Agena stage. Power capability is initially about 1500 watts which includes a 280-watt margin to allow for degradation during tests.

Project/Mission	Description
SNAP-8	SNAP-8 is a mercury-driven, Rankine cycle turbo-alternator power system using a solid-moderated (zirconium-hydride), reflector-controlled epithermal nuclear reactor for the heat source. The program is one of technology development leading to a long life (10,000 hrs or longer) space power system in the 30-100 KWe range.
RAM	The Radio Attenuation Measurements (RAM) Project is a series of ballistic reentry flights to investigate the interference of ionized flow fields with radio frequency transmission, communications and radar tracking for reentry spacecraft and to develop practical methods for eliminating this "blackout" phenomena. Spacecraft are launched into a ballistic trajectory of 750,000 feet apogee to obtain the reentry attitude and velocities required in the investigations. The primary data period is between the altitudes of 350,000 feet and 170,000 feet, in which the nominal velocity is 26,000 feet per second. Spacecraft are spin-stabilized to provide an angle of attack of less than 10° during the prime measurement period. The RAM spacecraft configuration is a truncated 9° half-angle cone which is capped with a hemisphere of 6-inch radius. The diameter at the base of the cone is about 28 inches; height is 51 inches. Of this volume, approximately one cubic foot is allotted to experiments. Each spacecraft weighs about 285 pounds, of which about 40 pounds is experiment instrumentation.
Space Applications	
ATS	The Applications Technology Satellite is about 3 feet in diameter and 4 feet long and grosses about 800 lbs in its earlier versions and about 2200 lbs in planned versions. Orbits are synchronous equtorial and 11,000 km at 28° inclination. Experiments include attitude control (3-axis, spin, and gravity-gradient stabilization), deployable antennas, despun antennas, meteorological TV and IR sensors, high-gain (40 db) antennas, multiple-access communications, aircraft-satellite voice communications, etc.
ATS Meteorological Satellite	The ATS Meteorological Satellites will be launched into synchronous atlitude orbits over the equator for viewing selected geographical arcs as required. These satellites are based on ATS spacecraft technology, but are configured for a meteorological mission as contrasted

Project/Mission	Description
ATS Meteorological Satellite (Continued)	to the ATS series of satellites which are configured primarily for a multidisciplinary mission, thereby constraining the test of certain meteorological experiments. A pair of satellites at synchronous altitude will provide for continuity of day and night cloud data over the Atlantic and Pacific and for the continuous tracking of balloons over extended geographic areas from which winds may be derived. The launch vehicle is a Thrust Augmented Thor-Delta.
Community TV Broadcast Satellite	A satellite launched by either an Atlas/Centaur or Titan III C into a geostationary orbit to demonstrate the technology required for transmitting high quality multi-channel (3-6) TV programs via satellites to moderate cost, specialized institutional receiving facilities ($500-$5,000) for distribution to classrooms, homes, and special groups.
Data Relay Satellite System	A tracking and Data Relay Satellite System (DRSS) will consist of several synchronous satellites relaying data from other Earth orbital mission spacecraft, both manned and automated, which require immediate transmission of information to mission control centers in the U. S.; the system would also provide a means of orbit determination. Such a system would provide 100% coverage for spacecraft in Earth orbit.
Direct TV Broadcast Satellite	A satellite launched by the Titan III or Titan III/Centaur launch vehicle, to transmit single channel UHF TV broadcasts to low-cost augmented home TV receivers ($50 to $200) for viewing by entire populations.
ERTS	The Earth Resources Technology Satellite is envisoned as a spacecraft in the 1000-lb gross weight category, stabilized in the Earth-pointing mode, and operating in a 500-nm sun-synchronous Earth orbit. Launch vehicle would be a Thrust Augmented Improved Delta. A growth version (5000 lbs) launched by an Atlas-Centaur to orbital altitudes of 300-500 nm is also planned. Multispectral equipment would be the primary remote sensor. This would be supplemented in the growth version with imaging radar and with high-resolution IR and microwave equipment.
GARP	The Global Atmospheric Research Program (GARP) is to provide world-wide atmospheric data measurements. World Weather Watch satellites support this program and are polar orbiting Nimbus-type observatories which will provide the global three-dimensional data on the

Project/Mission	Description
GARP((Continued)	mass and motion fields of the atmosphere, cloud patterns, precipitation patterns, and surface temperatures required by the GARP experiments planned for 1973 and 1976.
GEOS	The Geodetic Satellite is a 4 1/2-foot diameter octahedron about 2 1/2 feet long weighing about 400 lbs, launched by a Thrust Augmented Delta into a 600 nm orbit inclined at 20°. Instrumentation comprises beacons, transponders, and reflectors to permit very accurate position measurements from ground stations. Later flights include near polar inclinations.
Low Altitude Equatorial Satellite	The Low Altitude Equatorial Satellite will be based on Nimbus/TIROS spacecraft technology and will be launched into a low altitude circular orbit with very low inclination. This type of mission is required to obtain higher resolution tropical meteorological data and to meet the requirements for the high frequency of observations meaningful to tropical convective systems. The launch vehicle will be a Thrust Augmented Thor-Delta.
Navigation and Traffic Control Satellite System	Preliminary study results indicate that a two-satellite system in geostationary orbit containing L-band transponders that are capable of providing range signals and relay of data and voice communications will meet the mission objectives. The first flight will be based on SYNCOM, ATS-1 and possibly ATS-E spacecraft technology. The second flight will fly advanced instruments evolving from the Navigation SR&T and Advanced Applications Flight Experiment Program. The launch vehicle is a Delta/TE-364.
NIMBUS	The 3-axis-stabilized Earth-pointing NIMBUS spacecraft has a gross weight of 1000-1500 lbs in its different versions (B, D, E, and F) and orbits the Earth at an altitude of 600-850 miles in an 80° retrograde orbit. The spacecraft is a platform to develop Earth meteorological sensors such as visible and infrared spectrometers and radiometers, an image dissector camera system, filter-wedge spectrometers, UV sensors, etc. This spacecraft will be used in the World Weather Watch program. Launch vehicle is a Thrust Augmented Thor-Agena.
Synchronous Meteorological Satellite	The Synchronous Meteorological Program has as its objective the development and flight testing of an operationally oriented Integrated Systems Experiment synchronous

Project/Mission	Description
Synchronous Meteorological Satellite (Continued)	meteorological satellite. Proven sensors and supporting meteorological technological advances will be flown on advanced spacecraft evolving from the ATS F and G flights, launched by a Delta 364.
TIROS (M)	The 3-axis-stabilized, Earth-pointing TIROS M spacecraft weighs about 650 lbs. The power system is solar-cell battery with three deployable solar arrays generating 110 watts average. Launch vehicle is a Thrust Augmented Improved Delta and the nominal orbit is circular at 1380 km, inclined 82° retrograde. The instrumentation, providing cloud cover photographs day and night, comprises 2 advanced vidicon-recorder systems, 2 automatic picture transmission camera systems, and 2 high-resolution infrared radiometers. A solar-proton monitor and flat-plate radiometer have also been proposed.
TIROS Follow-on	The TIROS Follow-on program has the objective of developing advanced polar orbiting Integrated Systems Experiment satellite systems and improved operational sensors in support of the National Operational Meteorological Satellite System (NOMSS). The Improved TOS flights, which are ESSA-funded, may also carry R&D meteorological sensors where the development of such sensors is concurred in by ESSA and NASA, but is funded by ESSA.

Appendix II
Evaluation

APPENDIX II

EVALUATION OF ALTERNATIVE PROGRAMS

Introduction

This Appendix presents a possible quantitative procedure for the evaluation of candidate NASA programs. In addition, it may contain a mechanism for illuminating the interface between national requirements and NASA planning. A quantitative approach is chosen to facilitate a non-ambiguous description of the program evaluation rationale.

The evaluation scheme is based upon a comparison of program accomplishments (described in Chapter 6) against a set of weighted evaluation criteria. For this analysis the Agency goals identified in Chapter 4 are selected as the criteria. Depending on the degree to which it satisfies a criterion, a program is credited with some fraction of the weight accorded that criterion. The sum of these scores is a measure of the value of the program and is termed the program's "utility." This utility, alone or in conjunction with program cost, aids in establishing a ranking of programs.

Subjectivity enters the evaluation process in the (1) choice of evaluation criteria, (2) judgment of the weights assigned to each criteria according to the degree to which each responds to Agency goals, and (3) judgment of the utility of each program against the list of weighted evaluation criteria. Pursuit of disagreements over the conclusions of the evaluation process to one of these sources should serve to illuminate specific areas of controversy.

Application of the Evaluation Scheme

As an exercise probing the feasibility and usefulness of this approach to program evaluation, the three alternative programs synthesized at each funding level in Chapter 5 were subjected to a "straw-man" evaluation. The worksheet used is shown in Table II-1. The weights assigned to each evaluation criterion (Agency goal) are given in the first column. They represent a subjective evaluation of the relative importance of each Agency goal in the Agency's goals as a whole, i.e., 1000 points. This assignment of weighting factors, therefore, describes the various potential contributions of NASA to the national goals - it does not represent the relative worth of the national goals. Numbers in the next three columns would represent a judgment of the degree to which each of the three proposed programs contributes to satisfying each criterion.

After assigning utilities to each program and for each criteria, the columns would be added to determine the overall utility of the candidate program towards meeting the Agency strategy.

The numerical values selected for this "straw-man" evaluation are intended only to illustrate the technique. The criteria weighting factors and utility values could be determined through the NASA Planning System organization in order to reflect Agency thinking on the NASA role in fulfillment of national goals. As an alternative, the numerical values could be derived by first selecting the program with the greatest "management appeal." In any event, further study is necessary to determine how this formalism may be used in program evaluation to obtain the benefits of a structured approach.

TABLE II-1

WORKSHEET FOR EVALUATION OF ALTERNATIVE PROGRAMS

Agency Goals	Criteria Weighting (value judgment)	Alternative Program		
		Conquest of Space	Balanced	Returns of Space Activity
Support development of aeronautics and space technology and capability to meet military requirements	100			
Demonstrate and maintain technological strength in aeronautics and space	100			
Cooperate with other nations in aeronautics and space activity	50			
Develop aeronautics and space technology and capability to provide direct economic benefits to the nation	200			
Develop large-project management techniques which may be applied to solution of national problems	50			
Expand our scientific knowledge of the atmosphere and space	150			
Provide a focal point for the development of scientists and engineers	100			
Advance the national aeronautics and space technology and capability	250			
NET UTILITY	1000			

Appendix III

STUDY OF COSTING METHODOLOGIES

This Appendix is a report of a study of the costing methodologies used by the Program Category Working Groups in developing their Program Memoranda. The report is contained in a Bellcomm Memorandum for File of October 8, 1968, by Mr. W. J. McKune on the subject "Costing Methodologies of the Program Category Working Groups in the 1968 NASA Planning System."

BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: Costing Methodologies of the Program Category Working Groups in the 1968 NASA Planning System Case 103-5

DATE: October 8, 1968

FROM: W. J. McKune

ABSTRACT

The assistance which Bellcomm is providing for the NASA Planning System included a special study to determine the methodologies which the various working groups used in estimating future costs. This memorandum reports on this study.

In summary, different methods were used as was deemed cogent by those responsible for the estimate.

(a) Where proposed projects were similar to past or existing designs, historical data was projected considering changes in the design concept. This methodology was extensively used by the OSSA personnel.

(b) Where little historical base exists (in particular, Extension of Manned Space Flight) lump-sum estimates were made, at the module level, by cost analysts at the Centers in conjunction with conceptual design engineers. As such, these should correspond to those obtainable at the conclusion of a Phase A study.

(c) Where the major elements of costs were modifications to existing designs or hardware elements which had been extensively studied, cost estimates were based on manpower estimates of likely candidate contractors. This was used by the Lunar Exploration Working Group.

(d) The Space Biology Working Group developed a unique methodology to account for the wide variation in experiment packages and the high attrition rate of originally proposed (and funded) experiments.

In addition to detailing the methodologies, the report comments on the applicability of these to various situations.

In gathering the information, the strong impression was obtained that those involved in the process made a conscientious effort to depict accurate estimates. However, in almost every case, the estimator was allowed insufficient time to prepare the values in the manner he wished.

BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D.C. 20024

SUBJECT: Costing Methodologies of the Program Category Working Groups in the 1968 NASA Planning System Case 103-5

DATE: October 8, 1968

FROM: W. J. McKune

MEMORANDUM FOR FILE

1.0 INTRODUCTION

This document describes the procedures used by each of the NASA Program Category Working Groups to obtain the costs presented in the Program Memoranda (PM) submitted to the PSG/PCG in mid-July, 1968. Section 2 provides summaries of the methodologies and those cost omissions and duplications that have been noted. Section 3 summarizes the methodologies in terms of the projects which make up program options. Appendix I lists the individuals from whom the information was obtained.

2.0 SUMMARIES

Figure 1 summarizes the methodologies and lists cost omissions which have been detected. Since the cost estimates were prepared by many people throughout NASA, it was not possible to explore into sufficient depth to determine all omissions.

Figure 2 shows areas óf interface between cost estimates of the various groups.

3.0 PROGRAM CATEGORY WORKING GROUP METHODOLOGIES

3.1 Extension of Manned Space Flight Capability (EMSF)

The costs as presented in the July 15, 1968 version of the Program Memorandum were prepared on an extremely short time cycle with three principal inputs. Costs for launch vehicles were approximated from the time spread of costs from an output of the Apollo Cost Study (ACS) for a typical schedule. Costs for new developments (recurring and nonrecurring) were obtained by telephone conversations with Center cost analysts and design personnel and were based on work done in the parallel Intermediate Workshop Studies. Experiment costs were obtained from the Payloads Directorate of the Advanced Manned Mission Office. The PM values were selected at a meeting in July of representatives of the Centers, the cognizant program/project offices of OSSA, the Advanced Manned Missions Office and Bellcomm.

3.2 Lunar Exploration

A methodology having two unique features was used: (1) a particular contractor was assumed for each new development and (2) all estimates were initially derived in terms of the contractor's manpower requirements with the translation into dollars based on the contractor's estimated manpower cost.

Where the items of hardware were modifications to existing designs, the design contractor was assumed. For new designs, a contractor who had studied the equipment was chosen. A team of Headquarters and Center personnel visited each of the

PROGRAM CATEGORY	SUMMARY OF COSTING METHODOLOGIES	OMISSIONS
EMSF	APOLLO INVENTORY EQUIPMENT: APOLLO COST STUDY LAUNCH AND MISSION OPERATIONS: APOLLO COST STUDY NEW DEVELOPMENTS: ESTIMATE OF COST ANALYSTS AT CENTERS EXPERIMENTS: ESTIMATE BY ENGINEERING PERSONNEL	UNCERTAIN
LUNAR EXPLORATION	NASA ESTIMATES OF LIKELY CONTRACTOR'S TIME-PHASED MANPOWER REQUIREMENTS CONVERTED TO DOLLARS.	LAUNCH VEHICLES LAUNCH OPERATIONS MISSION OPERATIONS
PLANETARY EXPLORATION	ESTIMATES MADE BY CENTER WHICH WAS ASSUMED WILL BE RESPONSIBLE FOR PROJECT WITH HQ REVIEW	POSSIBLE INCREASE IN MISSION OPERATIONS COST DUE TO OVERLAPPING PROJECTS.
ASTRONOMY	EXTRAPOLATIONS ON A SUBSYSTEM LEVEL OF PAST EXPERIENCE FOR SIMILAR EFFORTS AND ON CONTRACTOR STUDIES FOR NEW DESIGNS.	—
SPACE APPLICATIONS	EXTRAPOLATIONS OF COSTS OF EXISTING DESIGNS	LAUNCH VEHICLE COSTS
SPACE PHYSICS	EXTRAPOLATIONS OF COSTS OF EXISTING DESIGNS AND CENTER IN-HOUSE STUDIES	—
SPACE BIOLOGY	EXPERIMENTS: UNIQUE TIME-PHASING OF EXPERIMENT PACKAGES BASED ON HISTORY OF EXPERIMENT ATTRITION AND COSTS SPACECRAFT: EXTRAPOLATION FROM EXISTING DESIGNS.	—
ADVANCED SPACE TECHNOLOGY	LEVEL OF EFFORT TO ACCOMPLISH SETS OF R&D OBJECTIVES	—
SUPPORTING ACTIVITIES (T & DA)	OPERATIONS COSTS OF EACH STATION FOR THREE MISSION MODELS. COSTS BASED ON NUMBER OF TELEMETRY LINKS, MAN-SHIFTS REQUIRED AND HISTORICAL RECORD OF COSTS OF EACH STATION.	OPERATIONS COSTS OF DOMESTIC STATIONS AND NASCOM.

FIGURE 1 - SUMMARY OF COSTING METHODOLOGIES

- BLANK INDICATES THAT NONE WERE DETECTED

a – ADV. TECH $ SUPPORT PROGRAM

b – OTDA $ SUPPORT PROGRAM

c – LAUNCH VEHICLE, LAUNCH & MISSION OPS COSTS INTERLOCKED

d – EMSF HAS ASTRONOMY EXP. $

e – EMSF HAS EARTH RESOURCES EXP. $

f – EMSF HAS PHYSICS EXP. $

g – EMSF HAS BIOLOGY EXP. $

h – PLANET HAS INSTRUM COSTS FOR SPACE PHYSICS

	EMSF	LUNAR	PLANET	ASTRON.	APPLIC.	PHYSICS	BIOLOGY	TECH.
LUNAR EXPLORATION	c							
PLANETARY EXPLORATION								
ASTRONOMY	d							
SPACE APPLICATIONS	e							
SPACE PHYSICS	f		h					
SPACE BIOLOGY	g							
ADVANCED SPACE TECHNOLOGY	a	a	a	a	a	a	a	
SUPPORTING ACTIVITIES (T&DA)	b	b	b	b	b	b	b	

FIGURE 2 – COSTING INTERFACES BETWEEN PROGRAMS

contractors and outlined the technical characterictics of each item. A contractor organization was structured to provide for all of the necessary functions to develop the hardware and conduct the mission. A schedule was postulated to define the activities of each portion of the organization and estimates of the manpower requirements as a function of time were derived. Figure 3 illustrates such a schedule. A manpower price structure for the contractor was deduced to account for past costs and expected plant loading. Costs were then obtained from the price structure and manpower loading.

Costs for launch vehicles, launch costs and costs for mission operations were not included.

The salient features of the estimates of the various hardware elements are discussed below.

3.2.1 Extended Lunar Module

The necessary modifications to the basic LM consist of the addition of cryogenic oxygen, solar panels and a radiator to provide a closed-loop ECS system. In addition to the manpower necessary to thus retrofit an Apollo LM, it was assumed that additional manpower cost would be entailed due to the rigid imposition of configuration management on the Apollo LM. It was reasoned that the major modifications to the LM will release many design improvements which have heretofore been suppressed.

Sustaining engineering manpower requirements for the basic LM were not included.

3.2.2 Particle and Field Satellite

These cost estimates were prepared by GSFC with reliance on historical data on IMP-type satellites.

3.2.3 Lunar Flying Unit

The methodology outlined in Paragraph 3.2 and illustrated in Figure 3 was followed.

3.2.4 Advanced Orbiter

The outlined methodology was followed assuming that the Lunar Orbiter experience was applicable. However, after completing the effort, it was suspected that the estimates were too high. Because of the similarity of this project and the Mariner '71, the outlined methodology was repeated, using a different contractor.

LUNAR FLYING UNIT
(DEMO)

		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	TOTAL
NON RECURRING		198	635	640	595	650	715	480	490	560	270	170	70									5473
ENGINE		140	320	245	195	200	170															1270
VEHICLE		58	315	395	390	400	450	350	300	250												2908
QUALIFICATION					10	50	55	90	150	200	200	100										855
SIM & TRAINING							40	40	40	110	70	70	70									
PRODUCTION BASE (4YR)					25	85	85	205	205	205	270	290	305									1675
ENG ENGINEERING	20																					
VEH	25																					
COMPONENTS	25																					
ENGINE PROD	60																					
FAB & ASSY	50																					
CHECKOUT	20																					
KSC OPNS	20																					
TRAINING	20																					
REL-ENGINE	50																					
REL-VEH	15																					
1ST FLIGHT UNIT					25	85	85	205	205	205	113	132	127									
		198	635	640	620	735	800	685	695	765	540	460	375									7148

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6-14-68

FIGURE 3 - MANPOWER ESTIMATES FOR LUNAR FLYING UNIT

COPY

3.2.5 Advanced ALSEP

The manpower estimates were based on the design concept outlined in "Apollo-Lunar Surface Experiment Package - Experimentors Design Criteria," March 1968.

The experiment costs were obtained by listing 19 likely experiments with expected costs for each. It was assumed that ten of these would be flown. The total cost was obtained as ten times the average of the nineteen.

3.2.6 Advanced Surveyor

These estimates were prepared by a subsystem-by-subsystem comparison of the design concept with the Surveyor design.

3.2.7 Lunar Payload Module

This estimate was made by the methodology described in Section 3.2. The only modifications to the Apollo LM considered were the removals of the ascent propellant and engines. Since the modifications are minor, the increase in cost due to the release of pending engineering change proposals was assumed to be negligible.

3.2.8 CSM - Science

The estimate was made in the method outlined in Section 3.2 with NAA providing the minor CSM modifications and a separate contractor for integration. The experiment costs were estimated by assuming selections of three packages of experiments on each spacecraft with manpower requirements for each.

3.2.9 Twenty-One Day CSM

It was assumed that the CSM life would be extended to 28 days by the AAP program. The estimate for the modification to 21 days was based on a scaling down of the expected cost of developing the AAP QCSM.

3.2.10 Three-Man LM, 90-Day Quiescent CSM

Cost estimates were not provided for the program option using these modules.

3.2.11 Lunar Logistic Vehicle

The method described in Section 3.1 was followed and was based on contractor studies of the Titan-Agena logistic lander.

3.2.12 Automated Surface Vehicle and Dual-Mode Roving Vehicle

These estimates were based on the One-Man Lunar Surface Scientific module experience for manpower estimates, with JPL providing additional cost estimates for the remote control features.

3.3 Planetary Exploration

The cost estimates for each project were made by a Center which was assumed by the Planetary Program Office (SL) to have the role of lead Center in planning. The rationale for this is that the estimate is a quasi-commitment on the part of the Center which will eventually do the work. The methodologies employed by each Center are discussed below.

3.3.1 Ames Research Laboratory (Venus and Mars Pioneer Orbiters, Jupiter Pioneer Flyby)

The estimates were initially prepared for Ames by TRW, Inc., based on past Pioneer experience. They were then modified and approved by the Pioneer Project Office at Ames. Little NASA in-house effort was assumed.

3.3.2 Goddard Space Flight Center (Venus and Mars Planetary Explorer Orbiters)

The estimates were extrapolated from the costs of Explorer 33-35 spacecraft based on an engineering examination at the subsystem level. The additional cost due to overlapping missions (two launch teams handling four spacecraft) was included. A substantial in-house effort was initially assumed by GSFC. The Program Working Group increased these costs to correspond to the use of a system contractor with little in-house effort.

3.3.3 Langley Flight Research Center (Mars Orbiter/Hard Lander (Small), Mars Soft Lander (Small), Mars Soft Lander Medium)

Cost estimates were obtained from Langley on an item-by-item estimate for each spacecraft based on Lunar Orbiter and Surveyor data. The items included recurring and non-recurring costs and development schedules for spacecraft subsystems, sterilization procedures, launch vehicle adapters and shrouds, and project-peculiar support from the Deep Space Network, Langley Research Center and Department of Defense. The estimates included inflationary considerations and system contractor fees.

3.3.4 Jet Propulsion Laboratory (All Others)

The cost estimates were prepared using the relationships described in a Planning Research Corporation report.* This detailed estimating method is based on available subsystem data from a wide variety of NASA and USAF projects. The costs are modified to reflect special constraints. Costs for missions beyond 1971 assume the use of system contractors.

3.4 Astronomy

Cost estimates for the three program alternatives relied heavily on experience with similar elements and on studies of advanced observatories.

Unit costs for sounding rockets and aircraft operations are well known. Costs for the Explorer, OSO and OAO projects relied to a great extent on past experience. The estimates were separated into experiments, spacecraft, and support (including data processing). The time-spread of costs for each of these was prepared from historical knowledge. For the spacecraft estimates, separate distributions were made for each subsystem. When improvements to a subsystem were planned, the cost of improvement was added (e.g., the three planned improvements in the data handling, stabilization and control and power systems to OSO I, J & K were reflected in increased costs of these subsystems). Figure 4 indicates the level of detail that was used.

Cost estimates for the Helios spacecraft were obtained from two studies.** These estimates were verified by comparing them with the known costs of the OSO and OAO.

The costs for the Orbital Workshop experiments were assumed to be of the size of the Explorer series.

Costs of launch vehicles were obtained from the Launch Vehicle Office of OSSA.

3.5 Space Applications

The cost estimates for the SR&T and for Advanced Applications Flight Experiments (AAFE) were based on the task requests which the various OSSA program/project managers have

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*"Development of Cost Estimating Techniques and Relationships for Unmanned Space Exploration Missions," Planning Research Corp. #R-870, Hoffman et al, Oct., 1966.

**"Advanced Orbiting Solar Observatory (AOSO) - Phase 1A Report," Republic Aviation Co., May 1965, and "Advanced Orbiting Solar Observatory - Phase II Report," Fairchild-Hiller, March 1966, Contract NASw-9146.

PROJECT	FY-70	FY-71	FY-72	FY-73	FY-74	TOTAL
OAO						
SPACECRAFT						
STRUCTURE	2.0	1.0				3.0
SUBSYSTEMS	5.8	14.8	7.4			28.0
STABILIZATION & CONTROL	3.0	7.0	2.0			12.0
DATA HANDLING	.8	2.5	1.7			5.0
COMMAND	.6	1.8	.6			3.0
POWER	.8	2.5	1.7			5.0
THERMAL	.6	1.8	.6			3.0
EXPERIMENTS	6.0	5.0	1.0			12.0
GROUND OPERATIONS		1.0	1.0			2.0
S/C SUPPORT	.8	.8	.4			2.0
DATA ANALYSIS			.5	1.0	.5	2.0
CONTRACT ADMINISTRATION	.4	.4	.2			1.0
TOTAL	15.0	23.0	10.5	1.0	.5	50.0

FIGURE 4 - BREAKOUT OF OAO SPACECRAFT COSTS
(IN MILLIONS OF DOLLARS)

received from the Centers in support of the various projects. Launch vehicle costs were not included in the July 15, 1968 version of the memorandum.

Other cost estimates which are peculiar to the Applications Program are discussed below:

3.5.1 Meteorology

• Nimbus New Starts

The cost estimates for the FY70 new start of Nimbus G and H are based on the known costs of Nimbus A through D and the anticipated run-out costs of Nimbus E and F. The spread of costs with time considered the expected schedule of the budget cycle and project approval dates.

• ITOS - Experiments

These costs were estimated to be a continuation of the expenditures for the development of experimental sensors to be flown on ESSA-funded TOS spacecraft.

• Meteorological/ATS

This new start in FY71 was assumed to be based on ATS I and III spacecraft technology so that its cost was minimum. A change from this technology would substantially increase the estimate.

• Synchronous Meteorological Satellite

The cost for this integrated systems test satellite is based on using the sensor technology of ATS I and III and spacecraft technology of INTELSAT. Use of this approach results in minimal development costs.

• TIROS Follow-On

The complexity of this development lies between the TIROS-M and Nimbus. Since a new spacecraft is involved, the costs were estimated to exceed that of TIROS-M but to be less than Nimbus.

• Low Altitude Equatorial Meteorological Satellite

This new start in FY72 was assumed to lie between a TIROS and a Nimbus in complexity. Since it is a new R&D satellite, costs of the Nimbus were used.

• World Weather Watch (GARP)

It was assumed that the contribution of the U.S. to this program would involve a series of Nimbus-type spacecraft. The number of these varies with each program option.

3.5.2 Geodetic Satellites

Three geodetic satellites are included in the Program Memorandum. The costs for GEOS-II are the expected costs for data handling for this satellite. The estimates to complete GEOS-D are approximated at twice that of GEOS-C due to the possible requirement for special ground equipment and special computer software to accommodate the flight altimeter. These costs will be better known after the prototype altimeter is flown on GEOS-C.

3.5.3 Navigation and Traffic Control Satellites

The cost estimate for the navigation and traffic control satellite is the average of the estimates from existing Phase A mission studies by RCA and TRW. The values are in substantial agreement with those developed in 1964 studies by Westinghouse and General Electric.

3.5.4 Earth Resources

Cost estimates for the three program levels ("austere," "reasonable" and "optimum") are based on an evaluation of what can and should be done at three levels of funding. The estimates each level presented in the Program Memorandum are discussed below:

- Sensor SR&T and Aircraft

The "reasonable" option provides a continuation of the present effort in sensor development and aircraft testing. The "optimum" estimate is based on the conclusion that approximately twice the present funding could be prudently spent. The austere is considered a "bare bones" amount. The aircraft costs include operating costs.

- Discipline SR&T

This category is for complete package investigations of high priority ad hoc questions from other agencies (as opposed to the development of sensors). The estimates are based on the same rationale as for sensor SR&T and aircraft.

- Earth Resources Technology Satellite

The estimates were based on conferences with contractors who build candidate satellites (RCA: Tiros; TRW: OGO; GE: Nimbus; and Boeing: Lunar Orbiter). The "reasonable" and "austere" options utilize Tiros technology and the "optimum" used Nimbus designs.

• Limited Objective Payload

These costs are for sensor development in which one or two sensors are tested on a small satellite or are carried piggy-back on another launch.

3.5.5 Communications/ATS

The estimates for the ATS satellites were based on the experience with the seven ATS which have been purchased (ATS A-E and two prototypes) and the completed Phase A studies on the second generation series ATS F & G.

The estimates for the SHF and UHF voice broadcasts satellites were estimated from completed studies by General Electric Corp. and RCA (Contracts NASw-1475 and 1476, respectively) and current SR&T studies with Hughes aircraft and Litton Industries on design concepts for the microwave transmitters.

The distribution and direct television satellite costs were somewhat speculative. They were based, in part, on work done by General Electric (Contract NASw3-9708) and partly on in-house effort.

3.6 Space Physics

Most of the activity of the Space Physics Program is a continuation of existing programs (OGO, IMP, Pioneer and the Explorer class). The cost estimates for these were made as a continuation of past costs and, through FY73, were drawn from the OSSA POP 68-1. The estimates for the new projects were prepared as discussed below.

The estimates for the solar probe were based on assumptions that the Germans would provide the satellite with the U.S. providing technical assistance, two or three experiments, the launch vehicle and its support and the data collection.

Estimates for the IMP series were based on an extrapolation of past costs at GSFC and included a subsystem-by-subsystem examination of each series to reflect planned upgrading (e.g., the data handling system cost for IMP-K and subsequent craft was increased because of the planned addition of a computer). The estimates included the anticipated costs of two years of data analysis for each spacecraft.

The costs for the Interplanetary Micrometeoroid Probe (Asteroidal Probe) and the meteoroid satellite were based on in-house studies at the Langley Research Center. These studies have not been formally documented.

The cost estimates for the relativity experiment were made by an OSSA/MSFC examination of various design concepts. The estimate is not considered firm since technical questions on thermal control and packaging of the maser are unanswered.

3.7 Space Biology

3.7.1 Experiments

A unique procedure for estimating the cost of experiments was used. This procedure was adopted to adjust for such peculiar features of bioscience experiments as the high attrition rate between concept and flight; a wide variation in experiment size; variations in numbers of experiments per spacecraft; and common and unique spacecraft requirements such as a life support system, close internal temperature control, and possible recovery.

The methodology used an experiment unit, a conceptual value that approximates the average number of experiments per flight taken over a series of similar spacecraft. It is assumed that six years prior to any flight, a definite number of experiment units are initiated for this flight. The rate of attrition with time was projected from historical data and experience data. A cost for each unit in each year was also obtained from historical data. From these a time-cost profile for each flight was obtained.

It was further assumed that one-third of the experiment units will be repeated each year for four years with an apportionment of costs in each year based on historical data.

The methodology may be compared to the cost of operating a school in which it is planned to graduate six students each year. Because of the historical attrition rate, eighteen students start the first year, with four dropping out that year. At the end of the sixth year, the desired six students graduate. Two of them then take a two-year graduate course. From historical data, the cost of each student in each year is known, so it is possible to construct a year-by-year cost profile.

An important advantage to this approach is that it provides a yardstick against which one can measure the apportionment of funds in a given year to the various activities such as SR&T, experiment definition, flight hardware design, etc.

SR&T fund estimates were obtained by assuming that these would provide for the first three years of an experiment life.

Details of the technique may be found in the document "Phasing and Resource Requirements for Future Bioscience Flight Programs" Ames Research Center, June 13, 1968.

3.7.2 Spacecraft

The costs of the Biosatellite spacecraft were obtained from the existing designs. The costs of the Improved Biosatellites were made by the Biosatellite office at the Ames Research Center in consultation with the Biosatellite contractor. Cost estimates for the Biopioneer were made by the Pioneer Office of the Ames Research Center and are based on the existing Pioneer designs.

Estimates for launch vehicles were made by the Launch Vehicle Office of OSSA.

3.8 Advanced Space Technology

The costs for the alternatives were based on the experienced judgment of the level-of-effort activity needed to execute advanced research and development at three levels. The values were obtained as an extrapolation of the run-out of existing programs and an estimate of the effort needed in selected areas where new starts are deemed advantageous. The Program Memorandum provides the amount of the estimate for each new start.

3.9 Supporting Activities (OTDA)

Two types of cost estimates are provided in the OTDA section of the Supporting Activities Program Memorandum: overseas operating costs and development costs for the relay satellite systems.

3.9.1 Overseas Operating Costs

The cost estimates were extracted from the OTDA document "Overseas Operations Study (SAS-9)." This study presents separate costs for operating the MSFN, DSN and STADAN, each with three mission models. A station-by-station workload forecast was made for each model in terms of man-shifts. Dollar costs were then obtained from historical costs at each station. A 5% inflationary factor was included.

The principal features of the MSFN costs were (a) an increase to two-shift capability to support Apollo and (b) a reduction in 85-foot station requirements and in ship and aircraft support for the less active models.

The STADAN analysis also included a station-by-station allocation to mission model projects, with the added detail of the number of telemetry links being received. This resulted in a reduction in links at some stations for light models and a closing of the Lima, Peru station for the lightest.

No costs were included for the domestic stations, NASCOM or for GSFC support.

3.9.2 Relay Satellite Costs

The cost estimate for the voice relay satellite system was prepared by GSFC based on the technology and costs of the ATS-1 and ATS-3. The costs for the data relay satellite system were obtained from the estimates contained in two studies.*

4.0 Conclusions

Three comments on the generalities of the estimating methodologies appear in order: (a) no distinction was made between costs and obligations in the values, (b) there was no uniformity as to the inclusion of inflationary effects and (c) the estimate did not indicate whether it was based on in-house integration or use of a prime contractor. In cases where prime contractors are involved, the type of contract is an important aspect of the validity of the estimates.

In gathering the information the strong impression was obtained that the individuals involved made a conscientious effort to produce accurate results. In almost all cases, much more detailed information was available to substantiate the value presented in the PM.

It would appear that considerable advantage might be derived by a consideration of the applicability of each of the four general methods used.

(a) Where proposed projects were similar to past or existing designs, historical data was projected considering changes in the design concept. This methodology was extensively used by the OSSA personnel.

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*"Orbiting Data Relay Network Study, Final Report," LMSC #699559, April 10, 1967, Contract NASw-1446, and "Orbiting Data Relay Network Study, Final Report," RCA #AED-R-3152, March 22, 1967, Contract NASw-1447.

(b) Where little historical base exists (in particular, Extension of Manned Space Flight) lump-sum estimates were made, at the module level, by cost analysts at the Centers in conjunction with conceptual design engineers. As such, these should correspond to those obtainable at the conclusion of a Phase A study.

(c) Where the major elements of costs were modifications to existing designs or hardware elements which had been extensively studied, cost estimates were based on manpower estimates of likely candidate contractors. This was used by the Lunar Exploration Working Group.

(d) The Space Biology Working Group developed a unique methodology to account for the wide variation in experiment packages and the high attrition rate of originally proposed (and funded) experiments.

In particular the methodology for estimating experiment costs appears applicable in areas where a high attrition rate exists between initial funding and flight of experiments. The rationale of using manpower costs of contractors appears quite sensible when modifications of existing items being manufactured are involved.

In gathering the information, the strong impression was obtained that those involved in the process made a conscientious effort to depict accurate estimates. However, in almost every case, the estimator was allowed insufficient time to prepare the values in the manner he wished.

WJ McKune

1014-WJM-gml W. J. McKune

Appendix I

PERSONNEL CONTACTED

In assembling the information contained herein, the following NASA personnel were contacted:

1. EMSF

W. O. Armstrong, MTX
W. J. Hammon, MTP
W. J. McKune, MTS
H. C. Mandell, ASTD (MSC)
E. W. Poore, BR-1
H. W. Vaughan, R-AS-SR (MSFC)
C. Williams, MPR

2. Lunar Exploration

F. W. Kretzmann, MPR

3. Planetary Exploration

R. S. Kraemer, SL
P. G. Marcotte, 724 (GSFC)

4. Astronomy

M. J. Aucremanne, SG

5. Space Applications

R. E. Alexovich, 9710, LRC
E. Ehrilich, SAV
J. J. Kelleher, SAO
R. L. Mandeville, SAF
J. R. Porter, SAR
J. E. Rosenberg, SAG
B. B. Schardt, SAN

6. Space Physics

M. J. Aucremanne, SG
C. T. D'Aiutolo, RV-1
T. L. Fischetti, SG
E. S. Ott, SG
A. W. Schardt, SG
A. H. Sures, SG

7. Space Biology

L. G. Goff, SB
D. K. Jenkins, SB

8. Advanced Space Technology

S. J. Grivas, P

9. OTDA Supporting Activities (T&OA)

J. C. Barrett, DHA-4
J. C. Bavely, TN
E. J. Stockwell, TN

Subject: Costing Methodologies of the Program Category Working Groups in the 1968 NASA Planning System Case 103-5

From: W. J. McKune

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NASA Headquarters

Messrs. W. O. Armstrong/MTX
M. J. Aucremanne/SG
J. C. Bavely/TN
R. E. Cushman/BX
C. T. D'Aiutolo/RV-1
F. P. Dixon/MTY
L. G. Goff/SB
S. J. Grivas/P
E. W. Hall/MTG
W. J. Hamon/MTX
C. W. Harper/RD-A
D. P. Hearth/SL
L. Jaffe/SA
T. A. Keegan/MA
R. S. Kraemer/SL
F. W. Kretzmann/MPR
D. R. Lord/MTD
R. L. Mandeville/SAF
J. L. Mitchell/SG
E. W. Poore/BR-1
D. E. Reynolds/SB
M. W. Rosen/W
L. R. Scherer/MAL
A. D. Schnyer/MTV
J. L. Sloop/RC
M. G. Waugh/MTP
J. W. Wild/MTE

Ames Research Center

L. Roberts/M

Bellcomm, Inc.

F. G. Allen
G. M. Anderson
A. P. Boysen, Jr.
D. A. Chisholm
C. L. Davis
D. A. DeGraaf
J. P. Downs
D. R. Hagner
P. L. Havenstein
N. W. Hinners

Bellcomm, Inc.

Messrs. B. T. Howard
D. B. James
J. Kranton
H. S. London
K. E. Martersteck
R. K. McFarland
J. Z. Menard
G. T. Orrok
T. L. Powers
I. M. Ross
F. N. Schmidt
J. W. Timko
J. E. Volonte
R. L. Wagner
J. E. Waldo

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Appendix IV
PSG Meetings

Appendix IV

MINUTES OF PSG MEETINGS

This Appendix contains the minutes of the following PSG meetings:

PLANNING STEERING GROUP

Minutes of the 1st Meeting

February 20, 1968

MEMBERS

Dr. Homer E. Newell, Associate Administrator
Chairman

Edgar M. Cortright, Deputy Associate Administrator for Manned Space Flight (Absent)

Oran W. Nicks, Deputy Associate Administrator for Space Science and Applications

H. R. Brockett, Director, Operations, Communications, and ADP, OTDA

Dr. Leonard Roberts, Director, Mission Analysis Division, OART

DeMarquis D. Wyatt, Assistant Administrator for Program Plans and Analysis

Dr. Alfred J. Eggers, Assistant Administrator for Policy

William E. Lilly, Assistant Administrator for Administration (Absent)

Arnold W. Frutkin, Assistant to the Associate Administrator

William A. Fleming, Office of Program Plans and Analysis
Director, Program Review Division

Joseph F. Malaga, Office of Administration
Director, Resources Analysis Division

N. B. Cohen, Office of Policy (Absent)

Douglas R. Lord, Deputy Director, Advanced Missions Programs, OMSF

Pitt G. Thome, Director, Advanced Programs, OSSA

Richard J. Wisniewski, Deputy Director for Programs, OART

Paul F. Barritt, Office of Tracking and Data Acquisition

Alfred M. Nelson, Office of Program Plans and Analysis
Secretary

OBSERVERS

Harold B. Finger, Associate Administrator for Organization and Management

J. Allen Crocker, Assistant to the Associate Administrator

I. The Chairman outlined the concept, framework, and working relationships of the Planning Steering Group. The Planning Steering Group will join Program Office deputy directors and chief planners with relevant functional staff offices in a single committee to direct and monitor agency-wide planning within the budgetary cycle and beyond. It will be chaired by the Associate Administrator. It will interface between the Management Council and a portion of the Planning Steering Group to be known as the Planning Coordination Group. The Planning Coordination Group, chaired by the Special Assistant to the Associate Administrator, will consist of the chief planners of the Program Offices plus the Functional Staff Offices concerned. It will be responsible at the working level for the planning process which will be carried on through Working Groups in each of the Program Categories identified by the Bureau of the Budget. The Working Groups will bring to bear program office, functional office and center representation. Their product will be in each case a Program Memorandum to present major planning alternatives to the Administrator. The Program Memorandum will be supported by a Planning Source Document which can contribute to Project Approval Documents and other requirements.

II. The need for guidance from the Management Council to the Planning Steering Group and its Working Groups was recognized and guidelines will be provided.

III. A work plan and schedule for the Planning Steering Group was distributed and discussed. A copy is attached. In addition to reviewing the program categories and making recommendations on the composition of the Working Groups, the Planning Coordination Group is to consider the Planning Source Document content and the Planning Steering Group role in Advanced Mission Studies.

IV. The Planning Coordination Group was asked (a) to review the program categories and make recommendations on changes they thought desirable; (b) to make recommendations on the Chairmen and composition of the Working Groups; and (c) to review present procedures for handling advanced mission studies and to make recommendations in regard to any changes that appeared necessary.

The action items assigned to the Planning Coordination Group are to be reported on or before March 8, 1968.

Alfred M. Nelson
Secretary

PLANNING STEERING GROUP

Minutes of the 2nd Meeting

March 5, 1968

MEMBERS

Dr. Homer E. Newell, Associate Administrator
Chairman
Edgar M. Cortright, Deputy Associate Administrator for Manned Space Flight (Absent)
Oran W. Nicks, Deputy Associate Administrator for Space Science and Applications
H. R. Brockett, Director, Operations, Communications, and ADP, OTDA
Dr. Leonard Roberts, Director, Mission Analysis Division, OART
DeMarquis D. Wyatt, Assistant Administrator for Program Plans and Analysis
Dr. Alfred J. Eggers, Assistant Administrator for Policy (Absent)
William E. Lilly, Assistant Administrator for Administration
Arnold W. Frutkin, Assistant to the Associate Administrator
William A. Fleming, Office of Program Plans and Analysis
Director, Program Review Division
Joseph F. Malaga, Office of Administration
Director, Resources Analysis Division
N. B. Cohen, Office of Policy (Absent)
Douglas R. Lord, Deputy Director, Advanced Missions Programs, OMSF
Pitt G. Thome, Director, Advanced Programs, OSSA
Richard J. Wisniewski, Deputy Director for Programs, OART
Paul F. Barritt, Office of Tracking and Data Acquisition
Alfred M. Nelson, Office of Program Plans and Analysis
Secretary

OBSERVERS

Admiral Weakley, Assistant Administrator for Management Development
J Allen Crocker, Assistant to the Associate Administrator

I. INTRODUCTION

The Planning Steering Group met to consider the recommendations of the PCG in regard to:

a. Program Categories
b. Program Category Working Group Chairmen
c. Procedures for Advanced Mission Studies
d. Content of Planning Source Document
e. Planning Guidelines
f. Role of Centers

II. DISCUSSION OF THE ACTION/AGENDA ITEMS

A. Program Categories

The discussion of the recommendation on the program categories resulted in tentatively adopting the following categories:

1. Extension of Manned Flight Capability
2. Lunar Exploration
3. Planetary Exploration (to include exobiology)
4. Astronomy
5. Space Applications
6. Space Physics
7. Bioscience (to include environmental biology)
8. Aircraft Technology
9. Space Technology
10. Supporting Activities

In addition to the above categories, a Special Launch Vehicle Group was agreed upon to handle special assignments.

The charging of OART space technology items to program categories wherever specific mission supporting roles can be identified was not decided. It was agreed that a decision on this is not required at this time. A presentation is to be made by OART personnel on this item.

B. Program Category Working Group Chairmen

The Program Category Working Group Chairmen were agreed upon and are included in the enclosure to these minutes. The suggested program and functional office personnel membership and appropriate center participation are also shown.

C. Procedures for Advanced Mission Studies

A procedure tentatively adopted by the PCG was presented. The procedure eliminates the requirement for submitting work statements and substitutes a brief one-page description to be prepared by the Program Office. This description will become a part of the PAD which will be revised to refer to the study description sheet. The requirement for the Associate Administrator to approve the contractor selection is also rescinded. Approval of each advanced study by the Associate Administrator is still required. A definition of an advanced study is to be prepared to help clarify the difference between advanced studies and studies conducted under SRT.

D. Content of Planning Source Document

An outline of the suggested content of the Planning Source Document as tentatively adopted by the PCG was submitted (copies previously distributed). This outline will be revised as experience dictates.

E. Role of the Centers

The role of the Centers and the need for their representation in the Working Groups was again stressed. A letter to the Program Office Associate Administrators from the Associate Administrator to be used as a basis for requesting Center participation was requested. It was agreed that the Planning Steering Group would assist in impressing the Centers with the importance of Center representation.

The need to ensure the presence of the Working Group Chairmen at the meeting of the Planning Steering Group with Mr. Webb on March 6 was stressed.

Alfred M. Nelson

Alfred M. Nelson
Secretary

PROGRAM CATEGORY WORKING GROUP
CHAIRMEN AND SUGGESTED MEMBERS AND
CENTER PARTICIPATION

1. Extension of Manned Flight Capability - Chairman, Douglas R. Lord, Deputy Director, Apollo Applications Program, OMSF.

   Suggested Headquarters Members:

   Bernard Maggin, Office of Program Plans and Analysis
   Ernest W. Poore, Office of Administration, Resources Analysis Division
   Dr. Franklin P. Dixon, Mr. Joseph Tschirgi, Mr. Robert Voss, and Dr. Jack Wild, OMSF
   Robert S. Gutheim, OSSA
   Dr. Walton L. Jones MD, Mr. Chatham, OART
   Paul F. Barritt, OTDA

   Suggested Center Participation:

   MSC, MSFC, LRC

2. Lunar Exploration - Chairman, Capt. Lee R. Scherer, Director, Lunar Exploration, Apollo Applications Program, OMSF.

   Suggested Headquarters Members:

   Albert O. Crobaugh, Office of Program Plans and Analysis
   Office of Administration, Resources Analysis Division (To be provided)
   Dennis James, OMSF

   Suggested Center Participation:

   MSC, MSFC, JPL

3. Planetary Exploration - Chairman, Donald P. Hearth, Director, Lunar and Planetary Program, OSSA.

   Suggested Headquarters Members:

   Luke L. Liccini, Office of Program Plans and Analysis
   Office of Administration, Resources Analysis Division (To be provided)
   Dr. William L. Haberman, OMSF
   Dr. James Downs, OMSF
   Robert S. Kroemer, OSSA
   Mr. Reece V. Hensley, OART
   Hugh S. Fosque, OTDA

Suggested Center Participation:

JPL, LRC, ARC

4. Astronomy - Chairman, Dr. Henry J. Smith, Deputy Director, Physics and Astronomy, OSSA.

Suggested Headquarters Members:

Milton J. Kramer, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided)
Dr. Harvey Hall, OMSF
Mr. Fred Allen, OMSF
Mr. Laurence F. Gilchrist, OART

Suggested Center Participation:

LRC, MSFC, ERC, GSFC

5. Space Applications - Chairman, Mr. Leonard Jaffe, Director, Space Applications Programs, OSSA.

Suggested Headquarters Members:

Luke L. Liccini, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided)
Dr. Charles A. Huebner, OMSF
Dr. Robert A. Summers, OMSF
Meteorology Sub-Committee - Chairman, Dr. Morris Tepper, OSSA
Earth Resources Sub-Committee - Chairman, Robert Porter
Communications, Navigation, Traffic Control and Geodesy Sub-Committee - Chairman, A. M. Gregg Andrus, OSSA
Frank J. Sullivan, OART
Dan S. Serice, OTDA

Suggested Center Participation:

GSFC, MSC, ERC, LeRC

6. Space Physics - Chairman, Mr. Jesse Mitchell, Director, Physics and Astronomy Programs, OSSA

Suggested Headquarters Members:

Donald P. Johnson, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided)
Dr. William Armstrong, OMSF

Suggested Center Participation:

GSFC

7. Bioscience - Chairman, Dr. Orr E. Reynolds, Director, Bioscience Programs, OSSA.

Suggested Headquarters Members:

Bernard Maggin, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided)
Dr. Sherman P. Vinograd, OMSF
Dr. Leo Fox, OART

Suggested Center Participation:

ARC

8. Aircraft Technology - Chairman, Charles W. Harper, Deputy Associate Administrator (Aeronautics), OART.

Suggested Headquarters Members:

Spiro Grivas, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided)
Albert J. Evans, OART

Suggested Center Participation:

FRC, LRC, ARC, LeRC

9. Advanced Space Technology - Chairman, John L. Sloop, Assistant Associate Administrator, OART.

Suggested Headquarters Members:

Spiro Grivas, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division (To be provided)
Eldon Hall, OMSF
Charles Davis, OMSF
James O. Spriggs, OSSA
Milan J. Krasnican, OART

Suggested Center Participation:

All Centers, participation of MSFC, MSC, KSC to be determined.

10. Supporting Activities - Chairman, Ralph E. Cushman, Director, Facilities Management Office, Office of Administration.

Suggested Sub-Committees and Chairmen:

Administrative Operations, Sub-Committee Chairman, Otis F. Redfield
Launch Vehicle Support, Sub-Committee Chairman, T. B. Norris
OTDA, Sub-Committee Chairman, Paul F. Barritt
Technology Utilization (To be provided)
University Affairs (To be provided)

11. Special Launch Vehicle Group - Chairman, Milton W. Rosen Senior Scientist, Office of Defense Affairs.

Suggested Headquarters Members:

Alfred M. Nelson, Office of Program Plans and Analysis
Thomas Campbell, Office of Administration, Resources Analysis Division
Arnold D. Sennyer, OMSF
Lester K. Fero, OMSF
Joseph B. Mahon, OSSA
Joseph E. McGolrick, OSSA
Adelbert O. Tischler, OART

Suggested Center Participation:

MSFC, LeRC, LRC, GSFC

PLANNING STEERING GROUP

Minutes of the 3rd Meeting

March 6, 1968

MEMBERS:

Dr. Homer E. Newell, Associate Administrator
Chairman
Edgar M. Cortright, Deputy Associate Administrator for
Manned Space Flight
Oran W. Nicks, Deputy Associate Administrator for
Space Science and Applications
H. R. Brockett, Director, Operations, Communications, and ADP, OTDA
Dr. Leonard Roberts, Director, Mission Analysis Division, OART
DeMarquis D. Wyatt, Assistant Administrator for Program Plans
and Analysis
Dr. Alfred J. Eggers, Assistant Administrator for Policy
William E. Lilly, Assistant Administrator for Administration
Arnold W. Frutkin, Special Assistant to the Associate Administrator
William A. Fleming, Office of Program Plans and Analysis
Director, Program Review Division
Joseph F. Malaga, Office of Administration
Director, Resources Analysis Division
N. B. Cohen, Office of Policy
Special Assistant to the Assistant Administrator for Policy
Charles W. Mathews, Office of Manned Space Flight
Director, Apollo Applications Program
Pitt G. Thome, Office of Space Science and Applications
Director, Advanced Programs
Richard J. Wisniewski, Office of Advanced Research and Technology
Deputy Director for Programs
Paul F. Barritt, Office of Tracking and Data Acquisition
Staff Scientist
Alfred M. Nelson, Office of Program Plans and Analysis
Secretary

Mr. Webb met with the Planning Steering Group and Program Category Working Group Chairmen to provide broad guidance to those who will be directly involved in Agency planning for FY 1970.

Dr. Newell reviewed the planning concepts and organization. The draft Management Guidance for Orientation of PSG Working Groups (enclosed) was discussed and revised by Mr. Webb.

Mr. Webb emphasized the challenge we face to define new starts which might gain support, the importance of a flexible approach which can establish the basis for work in specific areas short of total project authorization, and the possible application of the techniques of the Source Evaluation Board approach to budgeting/planning decisions.

s/Alfred M. Nelson
Secretary

Encl.

ORIENTATION OF PSC WORKING GROUPS

This is an interim and partial statement of guidance for the PSG planning complex which will be improved and updated from time to time. It should be used in the context of oral guidance provided by Mr. Webb March 6.

General Considerations

Election Year - Since 1968 is an election year, the President's overall budget will undoubtedly be debated vigorously. It is important that we provide the issues and facts to generate thorough public discussion of our program so that we can establish a sound basis for projecting that program into 1970.

Space Budget Planning - Careful examination of our budgetary experience shows that the successive reduced authorization and expenditure totals for the past several years are the product of two factors: (a) declining expenditures as major projects run out, and (b) a national budgetary-priority situation that has led the President to withhold approval for major new projects. In fact, our ongoing program has received essentially the support we have requested for it.

This clearly presents a challenge to us to develop the strongest possible basis for important new projects. (For example, by discussing Fiscal Years 1968 and 1969 together before the Congress, we gained an opportunity to initiate discussion of the values to be obtained from a manned workshop and to work toward it without requiring a complete definition that would be acceptable to all interests or final approval for an ultimate project. We are, therefore, in a good position to establish a stabilized base for continued work for our good people in the manned area and to develop and stimulate ideas for projects and experiments which might be associated with it. If our planning and the results of our work can attract and merit interest and attention in the emerging most attractive prospects, that interest and attention will in turn reflect itself in the kind of support for the program that will give it strength and staying power. This approach may be considered also in other program categories.) There are those aspects of this challenge to the officials of NASA which are of particular importance: (1) How do we most effectively utilize the capabilities and facilities we have brought into being? (2) What innovations can we introduce into our planning so that we make dollars go further? (3) How can we provide the needed close relationships on a continuing basis between planning and our pattern of scientific and engineering studies and developmental work on components and systems? We should not simply carry forward older planning in the belief that we will do as much or as little of it as dollars will permit; we should develop new concepts and new approaches to our objectives.

Soviet Space Activity - There is attached, for your reference, material utilized by Mr. Webb before the Senate. The prospect of major Soviet activities does not, however, reduce our own job to explain why our programs are important. Thought has to be~~en~~ given to the implications of specific Soviet projects which might mature earlier than our own. For example, some consideration should be given to contingency program adjustments that might be indicated if a manned lunar landing were accomplished by the Soviets prior to the successful accomplishment of the Apollo program.

3

Special Planning Considerations

Objectives and Purpose - In the past, executive and congressional recipients of budget presentations have felt inadequacies in material relating our project and program proposals to national needs and interests. Special attention should therefore be directed to explaining (a) the broad, long-term goals, and (b) the immediate purposes which programs are intended to serve. A given project will have its own more limited objectives which are intended to broader program objectives related to national needs and interests. Both should be fully developed as appropriate, in terms of rationale, cost-to-benefit relationships, relevance to user interests, expected social value, evidence of past benefits, etc.

Non-NASA Participation - NASA is associated with a number of government agencies and non-government institutions in the planning and implementation of programs. This comprehends our participation with the Department of Defense in the Aeronautics and Astronautics Coordinating Board and with PSAC; it includes the complex of steering committees and advisory boards which we have worked out with the academic community. The views and positions of these groups and any understandings we may have reached with them should be considered carefully. While they need not determine NASA decisions, they nevertheless merit full consideration. Where they support NASA program directions, it will be helpful to cite their views. Any dissenting opinions by such bodies relevant to alternatives proposed by Working Groups should be clearly identified and included in the resource material of the Working Group.

It will be necessary in some areas to consult directly with other agencies, particularly where their own user needs must be verified for reflection in our planning. It should be made clear to all involved that this consultation is for the purpose of developing alternatives in a planning process and does not imply decisions or commitments by NASA. The PCG Chairman must be kept currently informed of outside consultation.

NASA Centers - NASA competence is heavily concentrated in the Centers which must, therefore, be fully involved in the planning process, creatively and critically. A number of steps and management studies are underway to enhance this involvement of the Centers in a growing evolutionary process. Center participation in each of the Working Groups is provided for.

Alternatives - The products of the Working Groups will be in the form of alternatives rather than decisions or recommendations. It is vitally important that such alternatives be suitable for support, viable and useful in themselves. In a few instances in the past, weak alternatives may have been put forward without the intent to press for them in order to focus attention on one desired main proposal. Unless specific guidance to the contrary is given, alternatives should offer the option of rapid or slow advance. Thus, both technical and economic alternatives are ordinarily required. Consideration should also be given, in connection with alternatives, to differing requirements for NASA resources.

SRT and AMS - Each Working Group should consider and present the kind and extent of SRT and AMS required to support each program area. Long-Range considerations should be developed to serve as reference points for SRT and AMS planning and decisions. Thought should be given, in this connection, to imaginative ways to use facilities and equipment which exist for other purposes.

Program Categories

In each of the following categories, particular attention should be given to the factors listed, among others:

Extension of Manned Flight Capability - This program category, formulated by the Bureau of the Budget, interfaces with other categories where use of man in space may be desirable or necessary. The contributions which man may make in those cases should be coupled with the purposes and values of extending knowledge and capability of man in space per se, i.e., we need to explain what are the next jobs ahead for man and with man in space and why we want to do them.

Evaluate and phase the relationship between manned flight and space astronomy:

Take into account and consider, e.g., the PSC view that a workshop is naturally combined with biomedical and biological investigations (see PSAC report of 2/19/67, page 12);

Consider the implications for launch vehicle requirements and costs in the light of other current studies, e.g., AACB Launch Vehicle Panel studies and others.

Lunar Exploration - Describe our approach to plans for lunar exploration;

On the assumption that the Apollo objective will be met with the first landing on and return from the Moon, plus the landing of an ALSEP, what considerations should then apply to our objectives and us of capabilities?

Define the major decision points and indicate their timing;

Among the overall choices which should be developed are alternatives to multi-launch, large vehicle missions and, in lieu of comprehensive lunar exploration programs, selective lunar exploration possibilities.

Planetary Exploration - Considering the wide range of possible objectives from the innermost planets to Jupiter and beyond, and the spectrum of projects which were directed at the moon, identify alternative priorities for planetary exploration and justify the different rates of expenditure involved;

Consider the implications for the launch vehicle base and costs.

Astronomy - Provide a basis (in terms of goals, orderly development of art, flexibility) for evaluating alternative mission concepts;

Consider the relationship of man and telescope in terms of the state of the art for each in space, the optimum phasing of any interdependence, and the best mode of such interdependence.

Other Scientific Investigations in Space - Elaborate the basic purposes and benefits of bioscience activity;

Consider what working basis might be established for integrating bioscience with the study of man in space.

Development of Space Applications - Place central emphasis upon demonstration of the prospects for economic pay-off of proposed activities, particularly ERS.

Space Technology - Attempt to correlate technology development plans with potential uses, in terms of both utility and timing;

Attempt to correlate past activities with identifiable, positive results;

Consider opportunities to exploit technology for multiple uses.

Aircraft Technology - (The title of this Program Category, which is framed by BOB, should be broadly construed to equate with NASA's total aeronautical interests.)

Define a NASA concept of government responsibilities in civil aircraft technology;

Explain how proposed activities contribute to NASA's responsibilities in the government-wide picture;

Correlate past activities with positive results to the extent possible.

<u>Supporting Activities</u> - Develop alternative philosophies regarding the future size and responsibilities of NASA Centers and their relationship to industrial capabilities;

Consider a desirable and defensible balance of SRT and AMS as between the different program areas.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

April 30, 1968

MEMORANDUM TO DISTRIBUTION

FROM: AA/Assistant to the Associate Administrator

Subject: Actions and Guidance from Planning Steering Group Meeting of April 25, 1968

Members of PSG Attending:

Newell, Fleming, Wyatt, Nicks, Debus, Frutkin, Pickering, Clark, von Braun, Silverstein, Allen, Krieger, Thome, Mathews, Lilly, Eggers, Trimble (for Gilruth), Brockett, Roberts, Barritt, Wisniewski, Malaga, Cohen, Luskin, Stroud

Absent: Cortright, Bikle, and Elms

Ex Officio: Naugle, Mueller, Finger

ACTIONS

1. PCG/WG's should put their April 25th reports in the common format developed for that meeting. This material is to be sent to members of the PSG, along with copies of the April 17th submission by the WG's, for their consideration for the next meeting.

2. The WG's will be instructed to proceed meanwhile with their work, concentrating on the more obvious alternatives until PSG/MC can provide more specific guidance.

3. The approach to the organization and functions of the Institutional Working Group will be written up as presented and given to the Management Council for review and approval.

4. Dr. von Braun will send in comments on the launch Vehicle Working Group's study program to suggest items which should be emphasized and those which might be dropped.

5. The Administrator should be asked to reaffirm his guidance that the Apollo program be considered ended with the first successful landing and return.

6. The PSG will consider its schedule at its next meeting.

GUIDANCE TO WORKING GROUPS

1. Applications

In response to the question whether NASA should defer to another agency in initiating a development or project effort, the temper of the Group was more positive, suggesting that NASA should take the initiative.

2. Extension of MSF

The Working Group should emphasize the goal of providing a continuing program of manned space flight.

Further, it should identify, as a goal of the program, activities to forestall the pre-emption of space by others, thus preventing or constraining U.S. use.

3. Lunar Exploration

The WG should make the best possible case for a continuing Lunar Exploration Program.

The following program alternatives were developed:

(a) Consider Phase I of Lunar Exploration Program (LEP) as landings 1, 2, and 3, on current schedule, exploring several sites, using Apollo hardware and money.

(b) Consider Phase I of LEP as landings 1, 2, and 3, on stretched schedules to permit upgrading of mobility and/or science on surface, exploring several sites, using Apollo hardware and money plus some new hardware and money.

(c) Consider extending Phase I to 4, 5, or 6 landings, at one site or several sites, with modest increase in capabilities, using Apollo hardware and money plus new hardware and money.

(d) Consider proceeding to Phase II, either immediately or after a hiatus, with extended capabilities at one or several sites, using Apollo hardware and money plus significant new hardware and money.

This WG should also recognize national interest as a goal (see guidance to the MSF WG).

4. Planetary Exploration

The WG should devise a strategy and alternatives that respond to successes in exobiology and other areas.

Also, it should provide for "public appeal" in the mission profiles.

It was noted that this program category needs to be responsive to national interests as stated in the guidance to the MSF WG.

5. Launch Vehicles

The WG should study the option of developing a "low cost" Launch Vehicle.

It is agreed that the number of options (alternatives) for detailed study should be reduced. (Dr. von Braun agreed to prepare a letter giving his views on the most significant options for study and those which might be eliminated.)

6. Biosciences

The WG should develop a programmatic response to the question of whether the space flight primate experiments should be manned or unmanned.

7. Advanced Space Technology

It was requested that the viewgraph and copies titled "Priorities", be removed.

The WG should put emphasis on the primary goal of this category; specifically, to provide a technological base for space systems.

8. Astronomy Working Group

The WG should put emphasis on determining the manned mode associated with the ASTRA concept.

W. G. Stroud

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

May 1, 1968

OFFICE OF THE ADMINISTRATOR

MEMORANDUM

TO: DISTRIBUTION

FROM: W. G. Stroud, Secretary, Planning Steering Group (Acting)

Subject: Actions and Guidance from Planning Steering Group (PSG) meeting of April 26, 1968

Members of PSG Attending:

Drs. Newell, Clark, Wyatt, Eggers, Messrs. Lilly, Brockett, Thome, Nicks, Barritt, Lord (for Mathews and Luskin), Frutkin, Stroud, Cohen, Fleming, and Malaga

Ex Officio: Dr. Naugle

ACTIONS

1. A PSG meeting will be held at Goddard Space Flight Center on May 15 - 16, 1968, to provide guidance to Working Groups (WGs) on Program Memoranda factors.

2. The PCG will distribute copies of the official BoB letter of April 10 to members of PSG.

3. The PSG distribution list will include the Management Council as ex officio members.

4. Code B (Lilly) will provide members of PSG the year-by-year run-out costs of current programs, based on FY '69 Budget.

5. A draft statement of work will be prepared to cover the anticipated Bellcomm role in the planning system; concurrence of the General Counsel will be obtained.

ACTIONS, Con't.

6. The PSG recommends to the Associate Administrator for Advanced Research and Technology that he appoint representatives to the PSG with responsibility and availability comparable to that of the representatives of other program offices.

7. The Chairman of the PSG will discuss the membership of the Launch Vehicle Working Group with its Chairman.

8. Copies of significant, written materials sent to BoB will be sent to members of PSG.

GUIDANCE

1. Dr. Newell provided the following outline of the NASA Planning Systems, as it now stands, for discussion and consideration by the PSG.

a. PSG will operate under the general guidance of Management Council; the objective will be to develop a dialogue with Management Council so that guidance derives from an iterative process, freely and openly, with questions and answers flowing both ways.

b. PSG (which includes the PCG) is the unit for steering and guiding the planning activity; it should see that the system develops as a tool of the line organization as well as of the Administrator. The system will not succeed if two planning activities appear, one through PSG and the other through the line.

c. The schedule of activities is a matter for consideration by the PSG and can reflect the role that the PSG as a body wishes to exercise. The PSG can determine how often it wishes to meet relative to its operating arm, the PCG.

d. All members of PSG have direct access to the Chairman of PSG. This is an open invitation; the Chairman's secretary will be alerted to expedite appointments for PSG members.

e. The PCG has the task of carrying out the instructions of PSG; its job is to expedite the process, providing day-to-day guidance to see that it moves along. PCG should be alert to questions for the whole group; specifically, all questions of substance should be referred to PSG. For PCG members, the emphasis is on coordination.

In Summary --

The tasks of the PSG/PCG/WG activities are to make sure that the planning effort is properly sized in the sense that it will yield a number of good plans for the Administrator; that the issues are real; and that the alternatives span a reasonable range of strategies and resource requirements.

In the ensuing discussion, Wyatt contributed the view that the NASA Planning System might be put in better perspective if all recognize that we are dealing with two functions: planning, for which PSG/PCG is responsible; and decisions, for which the line organization is responsible.

2. The PSG instructed the members of Working Groups to respond freely to questions from BoB examiners; however, requests for written material should be referred to Code P (Wyatt), Code B (Lilly) or Code AA (Frutkin) as appropriate.

3. The response to the BoB SAS on Mission Models, due May 15, will be sent in parallel to PSG members. It will be forwarded to BoB through Management Council and the Administrator.

DECISIONS

Guidance from Management Council to Planning Steering Group and from Planning Steering Group to Planning Coordinating Group and Working Groups will be in writing.

LIST OF ENCLOSURES*

1. April 17th Working Group Reports to PCG

   a. Space Applications
   b. Space Physics
   c. Bioscience
   d. Astronomy
   e. Planetary Exploration
   f. Supporting Activities
   g. Extension of Manned Flight Capability
   h. Advanced Space Technology
   i. Lunar Exploration
   j. Aircraft Technology
   k. Launch Vehicles

2. April 25th Working Groups and PCG Presentations to PSG

   a. Lunar Exploration
   b. Aircraft Technology
   c. Space Physics
   d. Bioscience
   e. Astronomy
   f. Advanced Space Technology
   g. Extension of Manned Flight Capability
   h. Space Applications
   i. Planetary Exploration
   j. Supporting Activities
   k. Launch Vehicles
   l. PCG

**3. Minutes of PSG April 25th Meeting

**4. Minutes of PSG April 26th Meeting

5. Chairman and Membership of each Program Category Working Group

6. Format Guide for PSG Meeting (April 25th)

7. Bench Mark Program Elements - April 1968

8. BoB letter of April 10, 1968, to Mr. Webb re Planning for FY 1970 Budget

* Items crossed off indicate you received the correct copy at PSG's April 25th Meeting.

** Please note action items.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

June 3, 1968

OFFICE OF THE ADMINISTRATOR

MEMORANDUM

TO: Members, Planning Steering Group (PSG), Planning Coordinating Group (PCG), and Working Group Chairmen (see distribution)

FROM: AA/Acting Secretary, Planning Steering Group

Subject: Minutes of Planning Steering Group Meeting, 23 May 1968 at Goddard Space Flight Center

1. The PSG reviewed the work plan material that had been submitted by the Working Group Chairmen, and developed specific instructions to the Working Group Chairmen for their planning activities in the weeks ahead. These instructions will be incorporated in individual memoranda to the Chairmen of the Program Category Working Groups from the Chairman of the PSG.

2. Copies of the NASA Planning System document were distributed. The Chairman stated that this is the system and procedure that the Agency is following at the present time, and should be used as a guide by the PSG and working groups until a new edition comes out. Since we are experimenting with the planning process in an effort to develop an effective approach to planning, it is to be expected that members may have modifications to the guidelines to suggest. The Chairman would appreciate receiving such suggestions in order that they may be considered for the next edition.

3. The Chairman stated that a schedule of PSG activities would be distributed shortly. He asked the PSG members to give thought to the activities they would like to carry out in the Planning System. In particular, consider the schedule by which the PSG would meet already identified dates: 31 July for submission of draft Program Memoranda to the Bureau of the Budget; 6 September for initiation of Program and Budget considerations by the Administrator; and 30 September for formal submission to BoB.

4. The Deputy Associate Administrators were appointed as principal members of a group to work out a procedure for synthesizing a number of overall Agency plans for the Administrator's consideration. Volunteers from the membership of PSG were requested; depending on the number volunteering the Chairman will select a group to work with the Deputies.

5. The Chairman asked a group composed of the Deputy Associate Administrators to examine the question of developing procedures for approval of Advanced Mission Studies. A draft of an approach prepared by the PCG will be provided to them for initial consideration.

6. The Mission Model letter to the Bureau of the Budget in response to their Special Analytical Study has been approved by Mr. Webb. Copies have been distributed to PSG members.

7. The Charter and membership list of the Institutional Working Group (IWG), as concurred in by the Management Council, was distributed and discussed at some length. The guidance resulting from the discussion will be written up and transmitted to the IWG for its use.

8. Review of the material submitted by the Bioscience Working Group led to agreement to reorganize this Program Category activity.

9. The point was made, and agreed to, that a major Agency objective is the development of the Saturn V capability, not just its use.

WGS W. G. Stroud

Approval: Homer E. Newell

Homer E. Newell
Chairman, Planning Steering Group

PSG ATTENDANCE 23 May 1968, at Goddard Space Flight Center

NEWELL, Homer E.
FRUTKIN, Arnold W.
STROUD, W. G.
CROCKER, J Allen
THOME, Pitt G.
MALAGA, J. F.
LILLY, William E.
NICKS, Oran W.
SLOOP, John L.
ALLEN, H. J.
WEST, J. M.
TRIMBLE, G. S.
CLARK, John F.
CORTRIGHT, E. M.
PACE, R. E., Jr.
WILLIAMSON, David, Jr.
BROCKETT, H. R.
BARRITT, P. F.
HOWARD, Brian T.
WILLIAMS, F. L.
WEIDNER, H. K.
MATHEWS, Charles W.
ELMS, James C.
GILRUTH, R. R.
WYATT, D. D.
FLEMING, William A.
DONLAN, C. J.
BEELER, D. E.
HOCK, R. C.
SIEPERT, Al
DEBUS, Kurt H.
COHEN, Nathaniel B.
CUSHMAN, Ralph E.
GIBERSON, W. E.
WISNIEWSKI, R.
EGGERS, Alfred

ABSENT

SILVERSTEIN, Abe
KRIEGER, Robert L.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

26 June 1968

MEMORANDUM

TO : Members of the Planning Steering Group (PSG)
Members of the Planning Coordinating Group (PCG)
Other Attendees

FROM : AA/W. G. Stroud, Acting Secretary
Planning Steering Group

Subject : Minutes of Planning Steering Group Meeting, 19 June 1968

Attendance: Drs. Newell, Silverstein, von Braun, Jenkins; Messrs. Frutkin, Stroud, Donlan, Mathews, Nicks, Brockett, Hodges and West (for Gilruth), Downs and Howard (Bellcomm), Fleming, Doyle, Barritt, Thome, Felberg (for Pickering), Crocker, Cushman, Duberg (for Cortright), Rea, Chatham (for Wisniewski), Finger, and Lundin

Absent: Drs. Debus, Eggers, Allen, Wyatt; Messrs. Elms, Krieger, Bikle, Lilly, and Cohen

Agenda

As stated in Memorandum of 7 June 1968.

Actions

1. Membership of Institutional Working Group (IWG)

The Chairman of IWG was asked to review the membership of Group with view to insuring a technical and administrative composition best able to do the work of the Group.

2. Guidelines for Development of Manned Space Flight Program of 1970s (dated 19 June 1968).

The Chairman requested all members of PSG and Working Groups to use these guidelines.

In addition, he suggested that the other program offices might wish to develop similar guidelines for all or parts of their programs.

3. Advanced Mission Studies.

Members of PSG were asked to comment by 26 June on the AMS Approval Procedure document of 12 June 1968 distributed at the meeting and mailed to non-attendees. The Chairman indicated that Code AA would undertake to write up a separate policy statement on AMS to reflect a discussion on the point that contracted AMS should not be used to substitute for essential NASA thinking and responsibility.

4. Interfaces with BoB.

This matter will be discussed in an appropriate forum.

5. Volunteers for the Synthesis Activity.

This question was referred to Synthesis Group for resolution. (At its meeting on 20 June, the Group agreed that the volunteer group would be asked to undertake any special analyses required.)

<u>Guidance</u>

1. Space Biology Program Memorandum.

The Chairman indicated that there will be an internal Program Memorandum for the total Biosciences Program, prepared by the Chairman, Space Biology Working Group. For BoB, the PM would cover only the Space Biology program; exobiology will be covered in the Lunar and Planetary PM's, aerospace medicine and biotechnology in the EMSF PM.

2. Meeting of AA with Chairmen of the Working Groups and Deputy Associate Administrators.

At this meeting (14 June) the Chairman, PSG, provided the following guidance:

a. Working Groups are to keep working towards the July 15 deadline for draft NASA PMs and PSDs, (Working Groups should ignore the 31 July deadline which appears on the Schedule of 3 June since the requirement is being met by other action.)

b. The Deputy Associate Administrators were asked to oversee the Chairmen of the Working Groups in their Program Offices. This is to be interpreted as making sure that Chairmen perform the tasks required by the planning process and making sure that Working Groups include options of interest to the PO, but not excluding other options of interest to the Workings Groups.

c. NASA Planning System Documentation.

The PSD is not intended to be a separately written report for publication but basically a reference file, ordered and indexed according to the instructions in the PSD Guidance dated 5 June 1968.

<u>Decisions</u>

1. Review of NASA Planning System.

It was agreed that in August or September the PSG would review the NPS.

2. Schedule of NPS activities.

The 6/3/68 revised schedule previously distributed to members was reviewed and accepted.

Approved: Homer E. Newell
Homer E. Newell, Chairman

JUN 25 1968

cc:
Working Group Chairmen

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

JUL 26 1968

MEMORANDUM

TO : Chairmen, PCG Working Groups

FROM : Chairman, Planning Steering Group

SUBJECT: Guidance to Working Groups from PSG Meeting, 23-24 July 1968

The following represents further guidance from the Planning Steering Group to all Program Category Working Groups for inclusion in revised draft Program Memoranda due on 2 August 1968. Based on these revised draft PMs, final guidance where necessary will be provided for WG preparation of final PMs due 3 September 1968. The following guidance consists of general guidance applicable to the PMs of all Working Groups and specific guidance to individual Working Groups.

General Guidance

1. Program Memoranda text should effectively relate the alternative missions and projects identified to the stated objectives. How do the missions meet the objectives, and to what extent? What are the pros and cons of missions relative to objectives? (It was noted at the PSG meeting that the Lunar Exploration draft PM provides an exemplary case for treatment of alternatives and their evaluation. Another example is Attachment A which lists a set of criteria for evaluation of programs prepared by the Planetary Working Group; this may be of use, by adaptation, to the other WGs.)

2. At the end of each PM, there should be a summary analysis of any FY '70 decisions required. An outline for the content and format of such a summary analysis appears in Attachment B. Attachment C gives an example of this analysis as applied to Space Biology. (Space Biology should, of course, prepare its own analysis.)

3. The cost data of each Working Group should be in the same format, including all individual project costs, with L/V costs as a separate line. This format should be similar to that of Attachment C with the baseline program being the run-out of the current approved program (FY '69). In addition, the run-out costs of program decisions for the fiscal years '71 and '72 should be shown through FY '74. A column for FY '68 costs of the baseline program should be added.

Specific Guidance to Individual WGs

1. Planetary

(a) New starts should be clarified. What FY '70 decisions are necessary?

(b) Indicate a possible decision point sometime around 1975, in the phased option approach, which allows for a manned planetary option with an assumed target date of 1985. (This is for internal use only and should be on a separate page.)

2. Extension of Manned Space Flight

(a) Clarify the definition and limits of AAP with respect to the follow-on intermediate programs; also, consider improved nomenclature for the possible follow-on programs.

(b) The Earth Orbital Space Station should be called an Earth Orbital Space Laboratory.

(c) The EMSF and Lunar Exploration WGs should jointly pull together the total Apollo, Saturn V, and mission support and operations costs for the two programs; such total costs should then be apportioned appropriately and clearly shown in the two PMs.

(d) While experimental objectives in science and applications should be presented in general terms, it is questioned whether particular experiments or disciplines should be specified for given missions at this point in time before definitive studies are conducted.

(e) Further justification is required to support the judgment that the S-IVB W/S should be discarded as an option for the follow-on program.

(f) The total fiscal year '70 program put forward requires $32M for studies. In light of this fact, greater detail appears to be required in the treatment of the studies that would be done and the expenditure of these funds. What is the program logic or program development concept, by years, beginning with the conduct and content of these studies? How does AAP fit into this logic and what program development is premised upon it? (The AAP program should be fully treated in the PM.)

3. Lunar Exploration

(a) Develop a single-site manned option on a basis comparable to the multiple-site options in terms of approach, configurations, and costs.

(b) Show funding decision points in a manner similar to that used in the Planetary presentation.

(c) Relate option 1-B to 3-A and 3-B in a phased program approach, perhaps by slipping initiation of 3-A and 3-B; give consideration to phasing with the earth orbital program.

(d) Consider extended use of existing orbiters vs. a new orbiter.

(e) Spell-out the SRT program required.

(f) Taking the Lunar Exploration and Extended Manned Space Flights together, they appear to follow a strategy in which Saturn V's would be used exclusively for the lunar program, while the earth orbital program would utilize smaller vehicles. On this assumption, Saturn V production is continued or resumed exclusively to support the Lunar Exploration Program. What is the relative impact on lunar program options of having more or fewer Saturn V vehicles beyond the Apollo buy? (Include also costs beyond the Apollo buy for CSM and missions operations and support.)

(g) Given the larger real costs (based on the above) of manned options for Lunar Exploration and the fact that an earth orbital manned program would produce operational and technological values similar to some of those cited for manned Lunar Exploration, review the evaluation of unmanned alternatives in terms of their relative cost effectiveness in achieving primarily scientific objectives on the moon. Evaluate the extent to which the conduct of an unmanned Lunar Exploration Program presents unique technological and operational problems of a challenging and rewarding character.

(h) Implicit in the PM at several points is the strategical choice in the first half of the 70's between an exploratory (gross) cut at Lunar Exploration and an exhaustive, precise survey of the moon. This choice should be further articulated and a program option identified which reflects the exploratory approach.

(i) In responding to the last three points, provide the total costs--including Saturn V and Apollo hardware costs--for both the mixed and automated options assuming, first, that there is a Saturn 1-B earth orbital laboratory and then a Saturn V earth orbital program.

4. <u>Launch Vehicles</u>

(No further guidance from PSG at this time.)

5. <u>Space Applications</u>

(a) In cost comparisons, revise the funding levels to begin with assigned 1969 numbers and include funding associated with interagency programs.

(b) Change Special Data Mission to World Weather Watch.

(c) The PM does not make clear the relationship of the projects proposed to the various program strategies because insufficient information on the projects and their potential accomplishments is given. The PM should include brief paragraphs describing the projects and their potential achievements.

6. Aircraft Technology

(a) It is suggested that this PM would be strengthened if there were added a number of paragraphs identifying the potential benefits of the various program disciplines. This might be done in a manner similar to that in the SAS's. An objective of these additions should be the development of a better definition of what constitutes a "strong" program in aeronautics.

(b) Examine the concept of a "revolving fund" to carry DOD, DOT, and other work in the NASA Centers.

(c) Indicate where appropriate what other agencies are involved in the issues which are identified.

(d) The PM should reflect a more aggressive attitude in proposing programs which, though involving interagency interest, NASA feels are important in meeting national needs.

7. Advanced Space Technology

(a) With respect to the SAS on the Low-cost Booster, our position should be that the prospect will continue to be studied aggressively. (In our own work, consideration should be given to possible production in "commercial shops.")

(b) With respect to SNAP-8, the low option should be dropped from consideration as being too inconsequential in funding effects.

(c) With respect to the NERVA SAS, a review of the appropriate basis for a response to BoB is required.

(d) The PM should substantially expand its justification for the work requested and should explain and support the rationale for the increases desired. SRT and ART should not be justified on the basis of support for specific missions; thus, for example, it is suggested that the SNAP-8 development be justified not as a flight system, but as a means of developing the technology required for future large space-flight systems.

8. Space Physics

(a) Include the cooperative Solar Probe in all alternatives.

(b) Drop the alternative which is confined to earth environment work only.

(c) Provide for aggressive studies of low-cost spacecraft.

(d) Develop a simple analysis of the alternatives showing FY '70 starts, their specific purposes, the relationship to the next objectives, costs, and relative priority.

(e) The structure and internal discussions of the PM, its definition of alternatives and their relationship to objectives, the results expected for them, their cost effectiveness, and their evaluation, the character of the program with reference to the viewpoints of advisory bodies, and the program requirements in SRT--all could be considerably improved by reference to the treatment of these matters in other PM's, particularly Space Biology and Lunar Exploration.

(f) A minimum program option should be developed which, for example, would emphasize key breakthrough experiments, utilization of piggy-back and cruise-mode opportunities more than new spacecraft starts.

9. Astronomy

(a) The PM should express a program intention to increase our knowledge of the ability of manned flight to contribute to space astronomy.

(b) The Astronomy Program schedule, where it calls for manned activities, should coincide with manned flight program schedules.

(c) The PM should give more attention to other astronomy disciplines (e.g., radio astronomy).

(d) The Working Group is requested to provide the annual cost data for each of the individual projects making up the different alternative programs.

10. Space Biology

(a) Additional justification for primate work vs. manned work is needed in the PM.

(b) The PM should show an alternative which seeks to accommodate the program within the manned program.

(c) Should some caution be exercised in building considerable elements of the program on a need to explore the combined effects of weightlessness and radiation in view of the contradictory data cited and the absence of plausible mechanisms to account for a connection?

11. Supporting Activities

(a) T&DA should lay out major costs and the kinds of decisions that would have to be made to effect major economies through possible new tracking and data gathering systems.

(b) The premise is stated that flexibility in the TDA program is sharply limited by the fact that there is a two-year lag in the workload attributed to support of particular missions. Thus, it is stated that reductions in the fiscal year '70 program would not show up in TDA until 1972. This assumption appears to follow from acceptance of past TDA missions requirements as frozen. Thus, reductions in mission support could not be effected in 1970 below the levels established for data acquisition in 1968 missions. This assumption is questioned. Aggressive review of past data acquisition requirements and standards should be considered and should introduce flexibility into current TDA schedules and support requirements.

(c) The DRSS is discussed in terms of the advantages of 100% real-time satellite coverage. Should we accept an assumption of 100% real-time data acquisition as a broad goal rather than a special requirement in specific cases? Should the DRSS be supported on the basis of more flexible benefits?

for

Homer E. Newell

Attachments

cc: Management Council
PSG Members

ATTACHMENT A

BASIS OF EVALUATION

A. SCIENTIFIC RETURN

1. OVERALL ACCOMPLISHMENT OF OBJECTIVES AND GOALS
2. EVOLUTION AND CONTINUITY IN THE STUDY OF A GIVEN OBJECTIVE

B. RESOURCES REQUIRED

C. ADAPTABILITY TO CHANGING PRIORITIES, KNOWLEDGE GAINED, AND CHANGING AVAILABILITY OF RESOURCES (UP AND DOWN)

D. AVAILABILITY OF INFORMATION FOR FUTURE DECISIONS

E. VALUE IN TERMS OF BEING FIRST

F. LAUNCH VEHICLE AVAILABILITY

G. SUPPORT REQUIREMENTS AND FEASIBILITY OF SUCH SUPPORT

1. TECHNOLOGY
2. MANPOWER
3. TRACKING CAPABILITY (PERFORMANCE AND COVERAGE)
4. TECHNICAL FACILITIES
5. EXPERIMENTER PARTICIPATION

ATTACHMENT B

OUTLINE FOR PROJECT ANALYSIS
OF DRAFT PM's

I. Class of FY '70 Decision Required
(LoE, Extension or Follow-on, New?)

II. Extent of FY '70 Commitment Sought
What PPP Phase?
If Phase D, for how many?
Status of Supporting Development Plan?

III. Accomplishments if Approved
How stated?
Identifiable in terms of objectives?

IV. Major Corollary Decisions Required
A. FY '70 - CoF, L/V development, major AO revisions, etc.
B. Post '70 - CoF, L/V development or procurement policies, follow-on or extensions, supporting R&D projects, AO shifts, etc.

V. What is proposed as basis for evaluating among alternatives?

ATTACHMENT C

SPACE BIOLOGY PROGRAM

FY	69	70	71	72	73	74
BASELINE PROGRAM	30.7	35.8	34.8	29.0	18.3	8.2
SRT & Advanced Studies	7.1	7.2	7.2	7.2	7.2	7.2
Biosatellite (A-F)	23.6	28.6	27.6	21.8	11.1	1.0
FY '70 DECISIONS						
Biosatellite F/O (G-I)	-	1.0	4.5	16.5	21.9	17.5
Biosatellite F/O (G-H)	-	1.0	4.5	16.5	16.4	6.5
Improved Biosatellite (A-F)	-	1.0	6.2	12.7	22.4	25.0
Improved Biosatellite (A-F)	-	1.0	1.0	6.2	12.7	22.4
Advanced Biosatellite (A-D)	-	1.0	10.7	13.4	31.8	43.6
Bio-Explorer (A-B)	-	.5	4.3	5.8	5.0	-
Bio-Explorer (A-H)	-	.5	4.3	5.8	5.8	5.8
Bio-Explorer (A-H)	-	1.0	8.6	11.6	11.6	11.6
Bio-Pioneer (A-B)	-	1.1	2.9	7.2	9.4	5.6
Bio-Pioneer (A-B)	-	1.0	1.1	2.9	7.2	9.4

Space Biology Program

Project: Follow-on Biosatellite

Type of Decision: Follow-on to current program (A-F)

Extent of Commitment: Phase D start for either 2 or 3 more spacecraft; first launch in 1973; $1 million in FY 1970 commits to alternative runouts of $46 or $69 million.

Accomplishments:

Permits continuation of space biology without hiatus.

Relationship to other decisions:

a. FY 1970 - Improved Biosatellite or Advanced Biosatellite may be alternatives.

b. Post-1970 - May require future manpower increase at ARC.

Basis for evaluation:

a. Desirability of preserving flight continuity in 1973.

b. Cost comparison with Improved Biosatellite.

Space Biology Program

Project: Improved Biosatellite

Type of Decision: Follow-on

Extent of commitment: Phases B and C (Phase D scheduled for FY 1971)

Accomplishment:

Initiates design of improvements to on-going Biosatellite for increased lifetime and experiment flexibility; first launch would be in 1974.

Relationship to other decisions:

a. FY 1970 - Follow-on Biosatellite and Advanced Biosatellite may be alternatives.

b. Post- 1970 - May require future manpower increase at ARC.

Basis for evaluation:

a. Cost and accomplishment comparison with Follow-on Biosatellite and Advanced Biosatellite.

b. Cost per experiment- unit comparison.

Space Biology Program

Project: Advanced Biosatellite

Type of Decision: New start

Extent of commitment: Phase B and some critical experiment Phase C breadboarding (Phase D scheduled for FY 1971)

Accomplishment:

Initiates design of a new spacecraft 2½ times the size of Biosatellite with a lifetime of 3-6 months for large experiments.

Relationship to other decisions:

a. FY 1970 - none

b. Post-1970 - Initiation depends largely on level of space station commitment to space biology tasks.

Basis for evaluation:

a. Comparative cost per experiment unit through runout.

b. Size of experiments that should be flown.

Space Biology Program

Project: Bioexplorer

Type of Decision: New start

Extent of commitment: Phases B and C (Phase D is scheduled for FY 1971)

Accomplishments:

Initiates design of a small non-recoverable Scout launched spacecraft for 40- to 100- pound biology payloads with 5- to 10-day lifetimes.

Relationship to other decisions:

a. FY 1970 - None

b. Post-1970 - W. I. personnel

Basis for evaluation:

a. Comparative cost per experiment unit.

b. Flexibility at different budget levels.

c. Alternatives are flight rates and mission selections.

Space Biology Program

Project: Biopioneer

Type of Decision: New start

Extent of commitment: Phases B and C (Phase D scheduled for FY 1971)

Accomplishments:

Initiates the design effort for a modified Pioneer spacecraft capable of carrying biological samples for a year in a heliocentric, one- AU-radius, orbit.

Relationship to other decisions:

a. FY 1970 - None

b. Post-1970 - May require coordination with ongoing Pioneer project to assure minimum duplication of effort.

Basis for evaluation:

Included in all plans; no alternatives except first launch date (1973 vs. 1974)

Appendix V
PCG Meetings

Appendix V

MINUTES OF PCG MEETINGS

This Appendix contains the minutes of the following PCG meetings:

PLANNING COORDINATION GROUP

Minutes of the 1st Meeting

February 26, 1968

MEMBERS

Arnold W. Frutkin, Assistant to the Associate Administrator
Chairman
William A. Fleming, Office of Program Plans and Analysis
Director, Program Review Division
Joseph F. Malaga, Office of Administration
Director, Resources Analysis Division
Dr. Franklin P. Dixon (Substituting for Douglas R. Lord, Deputy
Director, Advanced Missions Program, OMSF)
Pitt G. Thome, Office of Space Science and Applications
Director, Advanced Programs
Richard J. Wisniewski, Office of Advanced Research and Technology
Deputy Director for Programs
Paul F. Barritt, Office of Tracking and Data Acquisition
Alfred M. Nelson, Office of Program Plans and Analysis
Secretary

INTRODUCTION

The Planning Coordination Group (PCG) met for the first time to address itself to four action items assigned to it by the Planning Steering Group (PSG). These actions are to be reported on by March 8 or sooner and were as follows:

a. Review and make recommendation on the present nine program categories.

b. Recommend composition of Program Category Working Groups.

c. Recommend content of a Planning Source Document.

d. Recommend role of Planning Steering Group organization in the Advanced Mission Studies area.

Items a. and b. were discussed and are reported on below. Items c. and d. will be discussed at the next PCG meeting which is to be held Thursday, February 29.

Recommendations and/or discussion on the action items were as follows:

(a) Review and make recommendation on Program Categories:

(1) Planetary Exploration: Change to Planetary and Interplanetary Exploration.

(2) Other Scientific Investigation in Space: Replace with two new categories entitled "Space Physics" and "Bioscience."

(3) Development of Economic Applications: Change to "Space Applications."

(4) Space Technology: Consideration was given to a suggestion that OART space technology items be covered in other Program Categories wherever specific mission supporting roles can be identified. Remaining items not chargeable to other specific categories would be included in a category entitled "Advanced Space Technology." OART is to provide further information and examples of how this would in fact work out. The PCC will then make a specific recommendation.

(5) Establish an internal working group for launch vehicles to prepare internal planning material in this area and to contribute specifically to program memoranda for BOB on requested items (Titan-Centaur and 100K thrust vehicle).

(6) Where manned flight and major scientific missions have been linked, the scientific missions should be covered by the appropriate Program Category rather than in the Category of Extended Manned Flight Capability (e.g., OSTRA to Astronomy).

(7) Further discussion is required in regard to the possible establishment of a new category which would include production, mission support and support engineering and maintenance for large and medium unassigned vehicles and spacecraft.

(b) Composition and Chairmen of "Program Category Working Groups."

The following are the recommendations for Chairman of each Category Working Group. (Individual members and appropriate Center representation are also suggested. However, the Chairmen should be free to work membership out to mutual satisfaction with Program Offices and Centers.)

(1) Extension of Manned Flight Capability - Chairman, John H. Disher, Deputy Director, Apollo Applications Program, OMSF.

Suggested Headquarters Members:

Bernard Maggin, Office of Program Plans and Analysis
Ernest W. Poore, Office of Administration, Resources Analysis Division
Dr. Franklin P. Dixon, Mr. Joseph Tschirgi, Mr. Robert Voss, and Dr. Jack Wild, OMSF
James O. Spriggs, OSSA
OART (To be provided later)
OTDA (To be provided later)

Suggested Center Participation:

MSC, MSFC, LRC

(2) Lunar Exploration - Chairman, Capt. Lee R. Scherer, Director, Lunar Exploration, Apollo Applications Program, OMSF.

Suggested Headquarters Members:

Albert O. Crobaugh, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided later)
Dennis James, OMSF
OSSA (To be provided later)

Suggested Center Participation:

MSC, MSFC, JPL

(3) Planetary and Interplanetary Exploration - Chairman, Donald P. [illegible]
Director, Lunar and Planetary Program, OSSA.

Suggested Headquarters Members:

Luke L. Liccini, Office of Program Plans and Analysis
Office of Administration, Resource Analysis Division
(To be provided later)
Dr. William L. Haberman, OMSF
Dr. James Downs, OMSF
Robert S. Kroemer, OSSA
OART (To be provided later)

Suggested Center Participation:

JPL, LRC, ARC

(4) Astronomy - Chairman, Dr. Henry J. Smith,
Deputy Director, Physics and Astronomy, OSSA.

Suggested Headquarters Members:

Milton J. Kramer, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided later)
Dr. Harvey Hall, OMSF
Mr. Fred Allen, OMSF
OSSA (To be provided later)
OART (To be provided later)

Suggested Center Participation:

LRC, MSFC, ERC

(5) Space Applications - Chairman, Mr. Leonard Jaffe, Director, Space Applications Programs, OSSA.

Suggested Headquarters Members:

Luke L. Liccini, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided later)
Dr. Charles A. Huebner, OMSF
Dr. Robert A. Summers, OMSF
Meteorology Sub-Committee - Chairman, Dr. Morris Tepper, OSSA
Earth Resources Sub-Committee - Chairman, Robert Porter
Communications, Navigation, Traffic Control and Geodesy Sub-Committee -
Chairman, A. M. Gregg Andrus, OSSA
Frank J. Sullivan, OART
OTDA (To be provided)

Suggested Center Participation:

GSFC, MSC, ERC, LeRC

(6) Space Physics - Chairman, Mr. Jesse Mitchell, Director, Physics and Astronomy Programs, OSSA.

Suggested Headquarters Members:

Donald P. Johnson, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided later)
Dr. William Armstrong, OMSF
OSSA (To be provided later)

Suggested Center Participation:

GSFC

(7) Bioscience - Chairman, Dr. Orr E. Reynolds, Director, Bioscience Programs, OSSA.

Suggested Headquarters Members:

Bernard Maggin, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided later)
Dr. Sherman P. Vinograd, OMSF
OSSA (To be provided later)
OART (To be determined)

Suggested Center Participation:

ARC

5

(8) Aircraft Technology - Chairman, Charles W. Harper, Deputy Associate Administrator (Aeronautics), OART.

Suggested Headquarters Members:

Spiro Grivas, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
(To be provided later)
Albert J. Evans, OART

Suggested Center Participation:

FRC, LRC, ARC, LeRC

(9) Advanced Space Technology - Chairman, to be selected.

Suggested Headquarters Members:

Spiro Grivas, Office of Program Plans and Analysis
Office of Administration, Resources Analysis Division
Eldon Hall, OMSF
Charles Davis, OMSF
James O. Spriggs, OSSA
OART (To be provided later)

Suggested Center Participation:

All Centers, participation of MSFC, MSC, KSC to be determined.

(10) Supporting Activities - Chairman, Ralph E. Cushman, Director, Facilities Management Office, Office of Administration.

Administrative Operations, Sub-Committee Chairman, Otis F. Redfield
Launch Vehicle Support, Sub-Committee Chairman, T. B. Norris
OTDA (To be provided later)
Technology Utilization (To be provided later)
University Affairs (To be provided later)

(11) Special Launch Vehicle Group - Chairman, Milton W. Rosen, Senior Scientist, Office of Defense Affairs.

Suggested Headquarters Members:

Alfred M. Nelson, Office of Program Plans and Analysis
Thomas Campbell, Office of Administration, Resources Analysis Division
Arnold D. Schnyer, OMSF
Lester K. Fero, OMSF
Joseph B. Mahon, OSSA
Joseph E. McGolrick, OSSA
Adelbert O. Tischler, OART

Suggested Center Participation:

MSFC, LeRC, LRC, GSFC

Alfred M. Nelson

Alfred M. Nelson, Secretary

PLANNING COORDINATION GROUP

Minutes of 2nd Meeting

February 29, 1968

MEMBERS IN ATTENDANCE

Arnold W. Frutkin, Assistant to the Associate Administrator
Chairman
William A. Fleming, Office of Program Plans and Analysis
Director, Program Review Division
G. E. Barber (Substituting for Joseph F. Malaga, Office of Administration, Director, Resources Analysis Division
Douglas R. Lord, Deputy Director, Advanced Missions Program, OMSF
Pitt G. Thome, Office of Space Science and Applications
Director, Advanced Programs
Richard J. Wisniewski, Office of Advanced Research and Technology
Deputy Director for Programs
Paul F. Barritt, Office of Tracking and Data Acquisition
Alfred M. Nelson, Office of Program Plans and Analysis
Secretary

INTRODUCTION

The PCG met to consider the remaining two action items assigned to it by the PSG. These are (a) content of a Planning Source Document and (b) role of Planning Steering Group organization in the Advanced Mission Studies area.

Discussion of the action/agenda items

(a) Planning Source Document - The discussion centered around the interrelationship of the Planning Source Document to the Program Memorandum, the Project Approval Document, and future planning considerations. The Planning Source Document should contain information to support these other documents and activity. A tentative outline of the content of the Program Source Document was agreed to on the basis that it would be changed and developed as experience dictates. A copy of the outline of the Planning Source Document content is enclosed.

(b) Role of Planning Steering Group organization in the Advanced Mission Studies area - A new procedure for obtaining Advanced Mission Study approvals was discussed. The procedure which was agreed to eliminates submission of work statements and the approval of contractor selections. Work statements, however, can be requested if the purpose or content requires examination in depth. An outline of the procedures tentatively adopted is enclosed. In this procedure, the PCG replaces the Planning Review Panel.

It was agreed that the Office of Program Plans and Analysis should take necessary action to rescind the directive requiring approval of the selection of the Advanced Mission Study contractor by the Associate Administrator.

(c) The Office of Tracking and Data and Acquisition submitted the following names for consideration by the Planning Coordination Working Group Chairmen:

Extension of Manned Flight Capability - Paul F. Barritt
Planetary and Interplanetary Exploration - Hugh S. Fosque
Space Applications - Dan S. Serice
Supporting Activities - Paul F. Barritt

Alfred M. Nelson
Secretary

Planning Source Document Content

The PSD is best thought of as a first-order derivative from the raw material developed by each Program Category Working Group and as a fundamental source for a second-order series of WG products. It would represent a refined, ordered version of studies, papers, and primary collections of data made by the WG from Program Offices, Centers, and other sources.

A PSD would be prepared by each WG in a form suitable for submission to the PSG and for consultation by the Administrator if he so desires.

The PSD is to have a basic relationship to PADs which will ultimately be drawn up. Therefore, it should contain —

(1) Objectives at the program and project level
(2) Resources required for alternatives identified, in dollars, manpower and facilities
(3) Schedules
(4) Rationale for selection to meet objectives

The PSD is the document from which Project Memoranda are to be drafted. The PM will, however, be very much shorter and less detailed and will confine itself largely to key issues. To accommodate the PMs, the PSDs must also contain —

(5) Principal issues addressed in planning
(6) Alternative project and program possibilities
(7) Bases for weighing alternatives
(8) Special studies conducted in the planning process

The PSD should further serve as a basis for a separate document collecting that part of the WG's work which is relevant for future planning considerations (FPCs), i.e., which relates to planning beyond the immediate budgetary cycle. For this purpose the PSD's should contain —

(9) Longer-term goals which were identified
(10) Alternatives anticipated in the more distant term
(11) AMS and SRT directions believed relevant
(12) Anticipated major management decision points

All the documents should be suitable for annual updating to the degree possible.

MJF
2/21/68

ADVANCED MISSION STUDIES

(Draft) Approval Procedure

(1) Use format similar to AMMP's 2/12/68 (one-page description*)

(2) Circulate to PCG and P for coordination by Secretary

(3) AA-F and PT review for sensitivity, relevance, and assure coordination

(4) Flag cases where work statement is desired before approval.

(5) Prepare PAD's in P, with copy to BR, attaching one-page descriptions

(6) Pass recommendations to AA for approval

(7) P to maintain total listing of AMS by contractor, subject, and program category

Outline to be followed

1. Study Title
2. Study purpose
3. Principal contractor tasks (very briefly stated)
4. Type of results expected
5. Potential use of results
6. Study Cost
7. Study Length
8. Study Management
9. Proposed method of procurement (Competition or Sole-Source to Contractor)

P
2/29/68

PLANNING COORDINATION GROUP

Minutes of 3rd Meeting

March 6, 1968

MEMBERS

Arnold W. Frutkin, Special Assistant to the Associate Administrator, Chairman; Charles W. Mathews, Director, Apollo Applications Program, OMSF; Pitt G. Thome, Director, Advanced Programs, OSSA; Richard J. Wisniewski, Deputy Director, Programs, OART; Paul F. Barritt, Staff Scientist, OTDA; William A. Fleming, Director, Program Review Division, OPP&A; N. B. Cohen, Special Assistant to the Assistant Administrator for Policy; Joseph F. Malaga, Director, Resources Analysis Division, Office of Administration (absent); Alfred M. Nelson, OPP&A, Secretary.

PROGRAM CATEGORY WORKING GROUP CHAIRMEN

Douglas R. Lord, Capt. Lee R. Scherer, Donald P. Hearth, Dr. Henry J. Smith, Jesse Mitchell, Dr. Orr E. Reynolds, Charles W. Harper, John L. Sloop, Ralph E. Cushman, and Milton W. Rosen.

OBSERVERS

Robert F. Allnutt, William H. Close, Robert J. Gutheim, Alex P. Nagy, and Donald P. Rogers.

GUIDANCE

The meeting of the PCG and the Working Group met after a PSG meeting with Mr. Webb to discuss further the relationship of the Management Council, the PSG, the PCWG and the concepts of the Planning Source Document and Program Memorandum.

The content of the Planning Source Document should support future Project Approval Documents, the Program Memoranda and the collection of Future Planning considerations identified in the planning process. The latter should serve as points of reference for Advanced Missions Studies and Supporting Research and Technology.

The Planning Source Document content outline provided to the Working Group Chaimen represents an initial suggestion which will require updating as the effort proceeds. The Program Memorandum is conceived as a "headless" document containing alternatives for consideration by the Administrator. The "head" of the memorandum, a summary and decision section, would be added by the Administrator for forwarding to the BoB.

The Working Groups will be responsible for preparing the Planning Source Document, the Program Memorandum, and Future Planning Considerations.

DECISIONS

Discussion of the Work Plan and Schedule provided to the Working Group Chairmen resulted in a decision to change the date for an initial report by the Working Groups from April 5 to April 17. A copy of the Work Plan and Schedule is enclosed.

ACTION ITEMS

It was agreed that the Working Group Chairmen would submit their membership lists to the PCG at its next meeting to be held March 13 from 8:30 to 9:30 A.M.

Alfred M. Nelson

Alfred M. Nelson
Secretary

Enclosure

WORK PLAN AND SCHEDULE

FOR PSG

By March 8	The PSG should (a) agree upon Program Categories (PC), (b) develop a broad guideline statement for each PC on goals, objectives, resource levels, specific missions, etc., (c) select the composition of Program Category Working Groups (PCWG) and special groups (i.e., Launch Vehicles).
By April 17	Each PCWG should respond to PSG with (a) an identification of principal issues in the category, (b) proposed alternatives to be studied, (c) a recommended basis for evaluating and judging the alternatives, (d) specific project proposals to be studied, and (e) proposed special analyses.
By April 30	The PSG should accept or amend PCWG proposals and issue specific task directives.
May - August	The PSG will conduct periodic reviews of progress in each PC and modify task directives as required.
By Sept. 1	Each PCWG shall summarize its work in a preliminary Program Memorandum (PM) (without recommendations).

P
3/21/68 Revised

PLANNING COORDINATION GROUP

Minutes of 4th Meeting

March 13, 1968

MEMBERS

Arnold W. Frutkin, Special Assistant to the Associate Administrator, Chairman; Charles W. Mathews, Director, Apollo Applications Program, OMSF; Pitt G. Thome, Director, Advanced Programs, OSSA; Richard J. Wisniewski, Deputy Director, Programs, OART (absent); Paul F. Barritt, Staff Scientist, OTDA; William A. Fleming, Director, Program Review Division, OPP&A; Joseph F. Malaga, Director, Resources Analysis Division, Office of Administration (absent); N. B. Cohen, Special Assistant to the Assistant Administrator for Policy; Alfred M. Nelson, OPP&A, Secretary.

PROGRAM CATEGORY WORKING GROUP CHAIRMEN

Douglas R. Lord, Capt. Lee R. Scherer, Donald P. Hearth, Dr. Henry J. Smith, Leonard Jaffe, Jesse Mitchell, Dr. Orr E. Reynolgs, Charles W. Harper, John L. Sloop, Ralph E. Cushman, and Milton W. Rosen.

OBSERVERS

Donald P. Rogers, Dr. Alois W. Schardt.

ACTION ITEMS

Each Working Group Chairman was requested to confirm final membership to the Secretary as soon as possible.

Messrs. Cushman, Fleming and Mahon were assigned responsibility for resolving how to handle the supporting engineering and maintenance of launch vehicles.

The PCG should determine whether the launch vehicle costing function in the Supporting Activities category should be place in the Special Launch Vehicle Group.

The Chairmen of the Working Groups are to provide the PCG an outline of the work areas each group expects to cover in their category and indicate expected areas of overlap so that these may be resolved at the earliest possible date. These outlines will also provide a means of assuring that there are no omissions. This item is in addition to those shown in the Work Plan and Schedule previously distributed.

The Chairman of the PCG will provide an outline of a typical Program Memorandum to each Chairman for his guidance.

Alfred M. Nelson
Secretary

PLANNING COORDINATION GROUP

Minutes of 5th Meeting

March 22, 1968

MEMBERS

Arnold W. Frutkin, Special Assistant to the Associate Administrator, Chairman; Charles W. Mathews, Director, Apollo Applications Program, OMSF (Absent); Pitt G. Thome, Director, Advanced Programs, OSSA; Richard J. Wisniewski, Deputy Director, Programs, OART; Paul F. Barritt, Staff Scientist, OTDA; William A. Fleming, Director, Program Review Division, OPP&A; Joseph F. Malaga, Director, Resources Analysis Division, Office of Administration; N. B. Cohen, Special Assistant to the Assistant Administrator for Policy; Alfred M. Nelson, OPP&A, Secretary.

PROGRAM CATEGORY WORKING GROUP CHAIRMEN

Douglas R. Lord, Capt. O'Bryant representing Capt. Lee r. Scherer, Donald P. Hearth, Dr. Henry J. Smith, Donald P. Rogers representing Leonard Jaffe, Jesse Mitchell (Absent), Dr. Jenkins representing Dr. Orr E. Reynolds, Charles W. Harper, John L. Sloop (Absent), Ralph E. Cushman, Milton W. Rosen.

OBSERVERS

Brian Howard, Bellcomm, W. G. Stroud, Jeff Barber.

GUIDANCE

Mr. Wyatt made a presentation to the PCG and PCWG Chairmen indicating the fundamental implications, in FY 1970 and through the next decade, of various funding levels provided to NASA by the BoB as planning guidelines for special studies required during the coming months. Copies of the vugraphs used in this presentation are enclosed.

As a consequence of the meeting between Dr. Newell and the Center Directors, Center Directors are added to the PSG. In addition, an Institutional Working Group is to be added to the PCG structure. A copy of the NASA PPB Plan - FY 1970 showing these changes is enclosed.

ACTION

Each Working Group Chairman will provide the Chairman with an outline of his work area and expected overlap. Notices of meetings, minutes and significant papers of each Working Group will be provided the Secretary who will keep the Chairman currently informed.

Alfred M. Nelson
Alfred M. Nelson
Secretary

Enclosures

WHAT OVERALL PROGRAM CONCEPTS CAN BE ACCOMMODATED WITHIN TOTAL BUDGET LEVELS OF $34, $41 AND $47 BILLION FOR THE TEN YEAR PERIOD FROM 1970 THROUGH 1979?

ONGOING PROGRAM

	FY 69	70	71	72	73	74	75	76	77	78	79	70-79 TOTAL
SRT & L.O.E.	368	368	→									3680
AIRCRAFT TECH	92	100	→									1000
SUPT ACTIVITY	1028	1040	1055	1077	1090	1100	1108	1115	1122	1130	1138	10775
ON-GOING DEVEL.	53	51	49	48	41	36	23	2	1	-	-	256
SUB-TOTAL	1541	1559	1572	1593	1599	1604	1604	1585	1591	1598	1606	15911
ON-GOING U/M PROJ'S	339	340	242	218	134	23	-	-	-	-	-	959
ON-GOING MAN. PROJ'S	2446	2077	1516	1548	1571	1450	→					15462
SUB-TOTAL	2785	2417	1758	1766	1705	1483	1450	→				16371
TOTAL	4326	3976	3330	3359	3304	3077	3054	3035	3041	3043	3056	32232

UNMANNED FLIGHT PROJECT RUNOUT

	FY 69	70	71	72	73	74	75	76	77	78	79	70-79 TOTAL
ASTRONOMY	68	55	9	2	-	-	-	-	-	-	-	66
PLANETARY	81	123	123	141	89	20	-	-	-	-	-	476
SPACE PHYSICS	50	42	22	20	9	-	-	-	-	-	-	93
BIOSCIENCE	38	18	7	1	-	-	-	-	-	-	-	26
SPACE APPL.S	88	96	75	50	35	3	-	-	-	-	-	256
ADV. SPACE TECH.	13	6	6	4	3	-	-	-	-	-	-	19
TOTAL	339	340	242	218	134	23	-	-	-	-	-	959

MANN~~A~~ED FLIGHT PROGRAM RUNOUT

	69	70	71	72	72	74	75	76	77	78	79	70-79 TOTAL
APOLLO	2007	1406	376	-	-	-	-	-	-	-	-	1782
AAP-1-7	276	211	199	145	125	-	-	-	-	- -	-	680
PROD, OP & SUPPORT	113	460	941	1403	1446	1450 →	→	→	→	→	→	12950
SAT-V WORKSHOP	50	-	-	-	-	-	-	-	-	-	-	-
TOTAL	2446	2077	1516	1548	1571	1450 →	→	→	→	→	→	15412

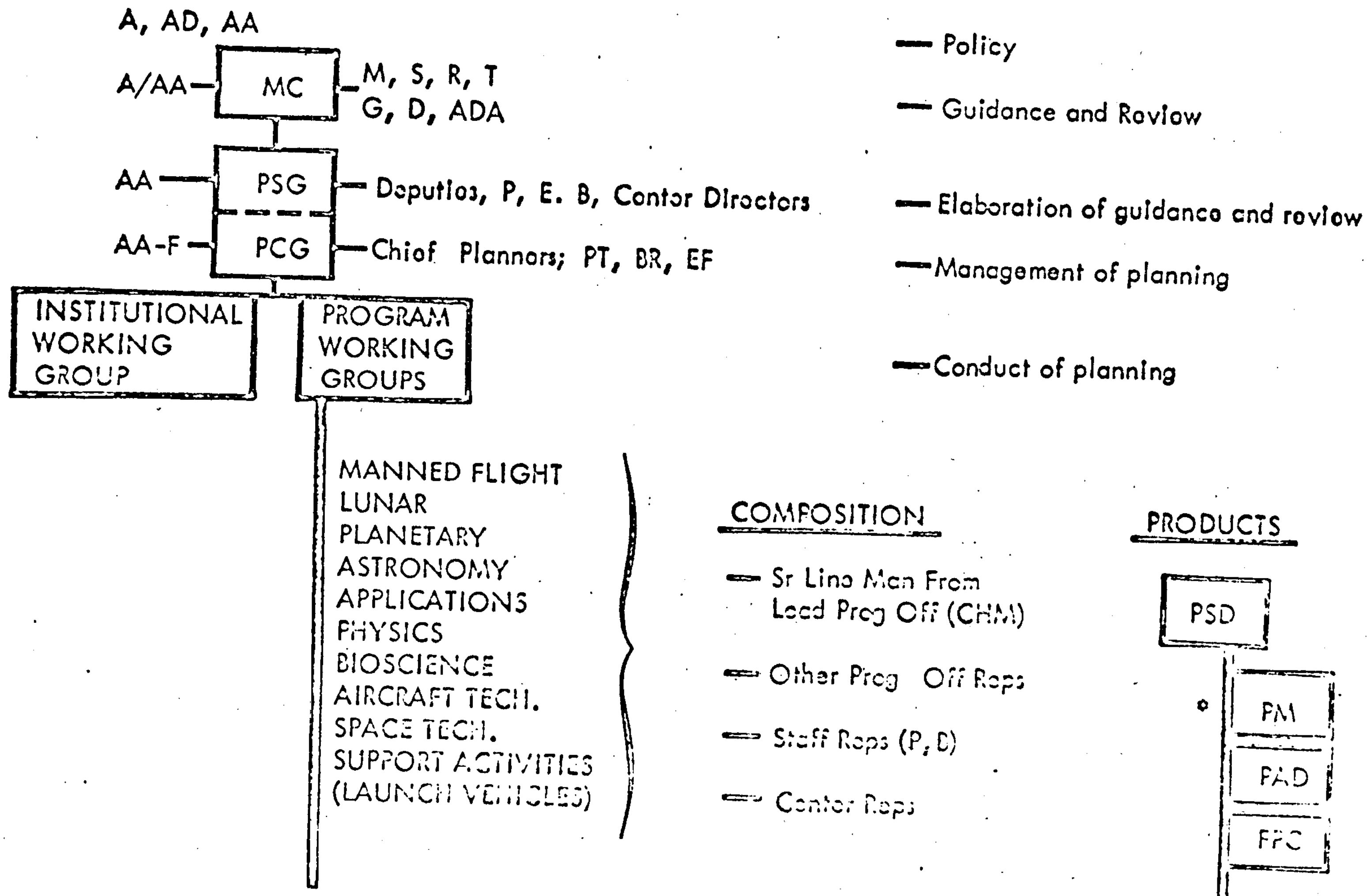
NEW UNMANNED FLIGHT PROJECTS AND ON GOING PROGRAM

	FY 70	71	72	73	74	75	76	77	78	79	70-79 TOTAL
ASTRONOMY	22	49	75	86	99	79	54	51	26	12	553
PLANETARY	97	299	384	341	397	399	414	422	338	142	3233
SPACE PHYSICS	1	7	19	29	30 →						236
BIOSCIENCE	25	62	50	47	49	44	40	38 →			432
SPACE APPLICATIONS	65	103	194	270	308	282	252	174	108	35	1791
ADV SPACE TECH	65	203	356	384	343	336	326	333	220	45	2611
SUB-TOTAL	276	723	1078	1157	1226	1170	1116	1048	760	302	8856
ON GOING PROGRAMS	3976	3330	3359	3304	3077	3054	3035	3041	3048	3056	32283
TOTAL	4252	4053	4437	4461	4303	4224	4151	4089	3808	3358	41133

MANNED FLIGHT PROGRAM

CY	69	70	71	72	73	74	75	76	77	78	79
PRODUCTION AVAILABILITY	THRU FY '69 →										
SATURN I-B	7	2	2	2	2	2	2	2	2	2	2
SATURN V	3	2	2	1 1	2	2	2	2	2	2	2
PROGRAM ALTERNATIVE											
SAT I-B WKSHP - SAT I-B		xxx	xxxxx								
SAT V WKSHP - SAT V					x		x		x		
- SAT I-B					xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	
LUNAR - SAT V		x	x	x							
EXCESS VEHICLES AT BASE PRODUCTION RATE											
SATURN I-B		6	3	5	3	1	(1)	(3)	(5)	(7)	
SATURN V		4	5	6	7	9	10	12	13	15	

NASA PPB PLAN - FY. 1970



AA - 3/15/68

PLANNING COORDINATION GROUP

Minutes of 6th Meeting

April 1, 1968

MEMBERS

Arnold W. Frutkin, Special Assistant to the Associate Administrator, Chairman; W. G. Stroud, Assistant to the Associate Administrator; Charles W. Mathews, Director, Apollo Applications Program, OMSF, (Absent); Pitt G. Thome, Director, Advanced Programs, OSSA; Richard J. Wisniewski, Deputy Director, Programs, OART; Paul F. Barritt, Staff Scientist, OTDA; William A. Fleming, Director, Program Review Division, OPP&A; Jeff Barber substituting for Joseph F. Malaga, Director, Resources Analysis Division, Office of Administration; N. B. Cohen, Special Assistant to the Assistant Administrator for Policy; Alfred M. Nelson, OPP&A, Secretary.

PROGRAM CATEGORY WORKING GROUP CHAIRMEN

Douglas Lord, Capt. Lee Scherer, Donald P. Hearth, Dr. Henry J. Smith, Leonard Jaffe, Jesse Mitchell, Dr. Orr E. Reynolds, Charles W. Harper (Absent), John L. Sloop, Ralph E. Cushman, Milton W. Rosen.

OBSERVERS

Dr. Jenkins, Donald P. Rogers, Otis Redfield, Brian Howard (Bellcomm).

GUIDANCE

1. Launch Vehicles - Working Groups should not make arbitrary assumptions regarding the use of a specific launch vehicle for a given project nor should they assume availability on a no-cost basis. They should assume the use of the cheapest effective vehicle on a chargeable basis.

2. April 17th report - This report is to explain how the Working Group means to approach its job, should be done in gross rather than detailed terms, should not include extensive text material, and should be directed to the principal issues and alternatives which the Working Group intends to address, particularly those with significant implications for budget requirements. (Additional guidelines will be provided at the next meeting.)

3. Alternatives - Mr. Webb's views and the possible scope of Congressional action require that wide-ranging alternatives be considered so as to provide extensive flexibility in integrating overall programs.

ACTION ITEMS

1. The Special Analytical Studies for the FY 1970 budget (enclosure to advance copy of BoB letter) are assigned for action as follows:

a. Alternative mission models for the 1970's - unassigned.

b. Orbital Manned Space Flight Studies - Mr. Lord (utilizing products of Dr. Thompson's Committee and Saturn V Workshop Study).

c. Lunar Exploration - Capt. Scherer.

d. Saturn/Apollo Hardware Production.

(1) Saturn V Production - Mr. Rosen

(2) Saturn IB Production - Mr. Rosen

(3) Apollo Command Module Production - Mr. Lord

(4) Apollo Service Module - Mr. Lord

(5) Apollo Lunar Module - Mr. Scherer

e. Planetary Exploration - Mr. Hearth

f. Earth Resources Satellite - Mr. Jaffe

g. Quiet Engine Project - Mr. Harper

h. Madrid 210 Ft Dish - Mr. Cushman

i. Tracking and Data Acquisition Overseas Operation - Mr. Barritt

j. National Launch Vehicles - Mr. Rosen

k. Federally Supported Astronomy (contingent upon major new starts) - Dr. Smith

l. NERVA I Development - Mr. Sloop

2. Any problem or difficulty in substance or timing that is foreseen in responding to the Special Analytical Studies requirements should be flagged in the April 17th reports and should precisely define the problem. In particular, a memo should be provided on the Quiet Engine Project.

3. Each Chairman will submit a list of any expected areas of overlap with another Working Group.

4. Mr. Wyatt should discuss with BoB the four S.A.S. which appear to constitute the entire job of the Working Groups and therefore should not have special study dates (Lunar Exploration, Launch Vehicles, Earth Resources, Planetary Exploration).

5. The Working Group calls for meetings and papers developed by the Working Groups should be sent to the office of the PCG Chairman.

6. Mr. Jaffe, Mr. Frutkin, and Mr. Stroud will meet to discuss SA plans for interagency coordination of the earth resources program requirements.

Alfred M. Nelson
Secretary

OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : For the Record

DATE: 9 April 1968

FROM : W. G. Stroud
AA-S

Distribution: Members, PCG
Chairman PSG
Dr. Homer E. Newell

SUBJECT: Minutes of PCG Meeting of 9 April 1968*

Attending: Frutkin, Mathews, Cohen, Barritt, Thome, Wisniewski and Stroud.

Absent: Malaga and Wyatt

Actions

1. Membership of PSG/PCG-WG

Stroud will get copies of membership lists to all PSG-PCG members.

2. Guidance to Working Groups for April 17 meeting

a. A memorandum outlining the format and schedule for the April 17 meeting will be prepared and distributed by Stroud.

b. Chief Planners are to distribute to Working Groups, as soon as possible, a model for their April 17 reports and a discussion of the required content which were both provided to them.

c. PCG extends its apologies to Scherer for the purely hypothetical treatment of the Lunar Exploration program in the Model Report which is distributed to Working Groups to assist them in preparing for April 17 meeting.

3. Other Guidance to Working Groups

The PCG will develop a list of general guidelines for all Working Group chairmen, including outlines and formats for the PM and the PSD. Thome and Cohen will take on task of drafting PSD outline for PSG/PCG review and comment. Stroud will furnish what notes already available.

* For agenda, see Attachment B

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

4. BOB Circular 68-2

Stroud will get copies to PCG members.

5. Rationalization of Agency technology programs

Frutkin and Stroud will prepare a memorandum for PCG review and discussion defining the subject question and proposing an approach.

6. Cohen on PSG

Cohen's name will be put on PSG membership lists as intended.

Decisions

1. Schedule of Activities

A schedule for Working Groups and other planning activities was agreed to and is outlined in Attachment A.

2. Integration (Synthesis) of Program Category Alternatives.

It was the consensus of the Group that the best approach to the synthesis of a number of alternative Agency programs would be to have the Chief Planners, with P and B, develop a number of strategies which would be critiqued and elaborated upon by separate MAD and Bellcomm activities.

3. Draft of NASA Planning System Document

It was agreed that the present draft needs tightening with the objective of making it more explicit and possibly more directive. In addition, a guidance, action and documentation flow diagram, a draft schedule of activities, and paragraphs defining the SEB character of the decision-making process will be added.

A correct set of references (with explanations) will be included with the draft.

Guidance

1. Name of NASA planning activity

The NASA planning system is not to be specifically identified as the PPB System, since the NASA plan will differ in significant features from that system. Until further notice, we will use the term, NASA Planning System (NPS).

Attachment A

Subject: Guideline, Schedules of PPB Planning Activities for 1968.

Attached is the proposed schedule of activities associated with the planning the Agency is doing for the FY 70 Budget submission to BOB. The deadline for submission of Budget and Program Memoranda to BOB is September 30. Between now and then the Working Groups must prepare their Planning Source Documents and the Program Memoranda, the Planning Steering Groups and the Management Council must pass on their contents, and the individual program alternatives must be integrated into a number of overall program alternatives for consideration and decision by the Administrator.

Some milestones are missing:

Dates are to be identified for W.G. submission of budget data so that Code BR can begin integration of the Budget.

Dates are to be identified for PCG and joint activities in the development and filling out of alternate mission models.

DATE	EVENT
April 17 Wednesday	W.G. Presentations (one-half hour each) to PCG
April 25 Thursday	*PCG, W.G. Chairmen Presentations to PSG on status
April 29 Monday	Presentation to MC
May 1 Wednesday	Deadline for MC and PSG/PCG Guidance to WG

Throughout May and June, brief meetings will be scheduled on a bi-weekly basis with W.G. chairmen to review status, provide PCG assistance where needed.

---

* Meetings of special importance to Center Directors

+ These are one-half day meetings between PCG and the full Program Category W.G. First drafts of program memoranda should be available prior to these dates for discussion.

Attachment B

Agenda:

a. Critical discussion of the draft NASA Planning System, distributed to you on 3 April.

b. Structuring of April 17 meeting, when Chairmen of Working Groups are to report.

c. PCG members' critique of progress, status, and problems.

d. Selection of PCG task teams to elaborate PSD, PM, and other documentation.

e. Proposal for integrating-synthesizing overall programs.

f. Question of rationalizing agency technology programs.

g. Other questions.

So-

+July 15 A.M. Monday P.M.	Applications W.G. Man Extension W.G.
July 16 A.M. Tuesday P.M.	Lunar W.G. Planetary W.G.
July 17 A.M. Wednesday P.M.	A/C Technology W.G. Astronomy W.G.
July 18 A.M. Thursday P.M.	Space Physics W.G. Bioscience W.G.
July 19 A.M. Friday P.M.	Adv. Space Tech. W.G. Launch Vehicle W.G.
July 22 A.M. Monday	Supporting Activities W.G.
July 25 & 26 Thursday and Friday	*Presentation to PSG
July 29 Monday	Presentation to MC
July 30 Tuesday	Guidance to PCG/W.G.
August	Synthesis by Joint Planning Group
September 3 & 4 Tuesday and Wednesday	Presentation to PSG
September 6 Friday	Presentation to A&MC
September 6 - 30	Agency Consideration
September 30	Agency Program Memo to BoB

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

May 10, 1968

MEMORANDUM

TO: DISTRIBUTION

FROM: AA W. G. Stroud, Acting Secretary WGS

Subject: Minutes of Planning Coordinating Group (PCG) Meeting of May 8, 1968

Attending: Frutkin, Thome, Cohen, Donlan, Barber, Fleming, Barritt, Howard, Doyle, Wisniewski, and Stroud

Agenda:

Advanced Missions Studies; draft issuance

Decisions:

It was agreed that a superior approach to that proposed in the draft would be to provide guidance to the Headquarters Program Offices and Centers as to which study areas might be sensitive and require Headquarters (Code AA) approval only for such studies.

Action:

The draft will be rewritten to reflect the discussion and resubmitted to PCG.

DISTRIBUTION

Members, PCG

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

May 10, 1968

MEMORANDUM

TO: DISTRIBUTION

FROM: AA/W. G. Stroud, Acting Secretary WGS

Subject: Minutes of Planning Coordinating Group (PCG) Meeting of May 9, 1968

Attending: Frutkin, Wyatt, Barritt, Cohen, Barber, Fleming, Doyle, Donlan, Thome, Howard, Krasnican, and Stroud

Agenda:

1. Mission Models for BoB/SAS-1

2. Outline of Planning Source Documentation (PSD) Contents

Actions:

1. Code P/Wyatt will redraft the proposed SAS-1 on Mission Models reflecting the PCG discussion which suggested that the best approach for submission to Planning Steering Group (PSG) and Management Council would be to emphasize the fact that only the Saturn-Apollo production variations permits any meaningful test of the sensitivity of mission alternatives.

2. The outline of the PSD contents, provided by Cohen and Thome, will be taken under consideration by all members of the PCG. Does the document yield Program Memorandum (PM), Project Approval Document (PAD), and Program Financial Plan (PFP) type information?

3. Copies of Code L/Weakley draft of PAD contents will be sent to Cohen and Thome.

4. Members of PCG will block out Tuesday and Thursday mornings (8:30 am - 10:30 am) on their schedules for several weeks beginning May 21 for PCG meetings.

DISTRIBUTION

Members, PCG

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

May 21, 1968

MEMORANDUM:

TO: Members of the PCG (See Distribution)

FROM: AA/W. G. Stroud, Acting Secretary

Subject: Minutes of Planning Coordinating Group Meeting of 16 May 1968

Attending: Messrs. Frutkin, Donlan, Cohen, Fleming Thome, Howard, and Stroud

Absent: Wisniewski, Barber, Barritt

AGENDA

1. Earth Orbital Experiment Program and Reference Study

2. Outline of Contents of Planning Source Document (PSD)

ACTION

Messrs. Cohen and Thome will complete the draft outline of the PSD rearranging it as agreed, improving those parts that need better definition and adding a paragraph defining the degree of completeness and polish required for the PSD this year.

DECISIONS

PCG meetings will be held only on Tuesdays at 8:30 a.m., rather than Tuesdays and Thursdays as previously discussed.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

June 13, 1968

OFFICE OF THE ADMINISTRATOR

MEMORANDUM

TO: Members, Planning Coordinating Group (PCG)

FROM: AA/W. G. Stroud, Secretary (Acting)

Subject: Minutes of Planning Coordinating Group Meeting of 4 June 1968

Attending: Messrs. Frutkin, Thome, Barritt, Fleming, Barber (for Malaga), Lord (for Donlan), Cohen, Stroud, and Doyle

Absent: Mr. Wisniewski

Agenda

1. Planning Source Document Description (PSD)

2. Budget Structure and Guidelines

Actions

1. Chairman PCG will distribute Memorandum of 31 May containing guidance to Chairmen of Working Group on preparation and distribution of draft PSD and Program Memorandum.

2. Wisniewski is to provide justification and an estimate of ability to meet schedule if OART budget structure is changed to three program categories. In the meantime, Working Groups and Program Categories will continue as they are, i.e., with the A/C Technology and Advanced Space Technology Categories.

3. Barber is to provide a list of subcategories and elements for the Lunar Exploration Program Category.

4. All members are to examine the budget structure proposed and submit changes or corrections to Barber by 6 June.

5. Chairman, PCG will ask Chairman of Institutional Working Group if manpower data requested in Budget Structure and Guidelines document is suitable for the purposes of that group.

6. Codes SD and B will be asked to resolve question of detail required in bases of cost estimates as soon as possible.

7. Chairman, PCG will send copies of Planning Schedule to all Working Group Chairmen.

8. Mr. Fleming will draft a memorandum to Chairmen, Working Groups inviting them to join PCG meetings to discuss any question or problem they may have.

Guidance

The PSD contains the basic outline of the PM. Thus, the PM should follow the outline of the PSD. However, the PM is limited to 20 pages and must therefore emphasize the more important options and issues which must be considered by top management.

Approved: ______________________
Arnold W. Frutkin, Chairman

cc:
Working Group Chairmen

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

June 13, 1968

MEMORANDUM

TO: Members, Planning Coordinating Group (PCG)

FROM: AA/W. G. Stroud, Secretary (Acting) WGS

Subject: Minutes of Planning Coordinating Group meeting, 11 June 1968

Attending: Messrs. Fruckin, Thome, Donlan, Cohen, Fleming, Chatham (for Wisniewski), Stroud; also Howard, Downs, and Doyle

Absent: Messrs. Barritt, Malaga

Agenda

1. NPS FY '70 Budget Structure and Guidelines

2. Schedule of Activities

3. Program Memoranda

Actions

1. Chairman of PCG will distribute copies of FY '70 Budget Structure and Guidelines draft after final coordination with Code B.

2. Fleming is to get complete schedule of Special Analytical Studies submission dates from Working Groups in time for 14 June meeting.

3. Chairman PCG will put out memorandum inviting Working Group Chairmen to Planning Steering Group (PSG) meeting of 19 June.

4. Members of PCG are to think about question of how PSG/PCG process might select the program options that should be priced out when Code B issues a Budget call.

Guidance

The Chairman provided further definition of the Program Memorandum and its schedule:

1. Draft PM Outline (for PSG) (WG responsibility)
4/17-4/25; 5/23

2. Draft final PM (for PSG) (WG responsibility)
7/15

3. PM Outline for BoB (Code P responsibility)
7/31

4. a. Final PM for A (WG responsibility)
9/6

b. Agency-wide PM for A (PSG responsibility)
9/6

5. Items 4a and b to BoB 10/1

Decisions

The members had no comment on the PSG/PCG schedule of activities dated 6/3/68.

Approved: [signature]
Arnold W. Frutkin, Chairman

cc:
Working Group Chairmen

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

June 19, 1968

MEMORANDUM

TO: Members, Planning Coordinating Group (PCG)

FROM: AA/W. G. Stroud, Acting Secretary

Subjects: Minutes of Planning Coordinating Group meeting, 18 June 1968

Attending: Messrs. Frutkin, Donlan, Cohen, Malaga, Fleming, Howard, Thome, Karsnican (for Wisniewski), Barritt, and Doyle

Absent: Mr. Stroud

Agenda

1. Report on AA/Working Group Chairmen/Deputy Associate Administrator meetings of 14 June 1968.

2. Status of:

   a. AMS approval procedure

   b. Synthesis activities

   c. Bellcomm role in NPS

   d. Budget structure and guidelines

Actions

1. Copies of final draft of AMS approval procedures sent to Management Council for their comments are to be sent to PCG members.

2. Copies of FY 1970 Guidelines and Assumptions document, prepared by Code B and sent to Working Groups by PCG Chairman, are to be sent to PCG members.

3. When completed, copies of Bellcomm Work Statement will be sent to PCG and PSG members.

Guidance

The Chairman, PCG, reviewed the status of the synthesis activities, describing the presently proposed approach to synthesizing and developing the various program category options identified by each of the Working Groups into overall Agency Program Options.

The Ad Hoc Group of PSG members (consisting of Dr. Newell, the four Deputy Associate Administrators, Frutkin, Wyatt, and Lilly) will select options identified by the Working Groups and build up several Agency-wide Program alternatives. These overall Agency options, along with other inputs, will be presented to the Administrator and Management Council for an "SEB-type" selection process.

For example:

WGs	Options Developed by WGs →	Synthesis into Agency Options → I	II	III	MC/A for "SEB-type" selection process, e.g., II
1.	a b c	b	c	a	c
2.	a b	a	b	a	b
3.	a b c d	d	d	c	d
etc.	etc.	etc.	etc.	etc.	etc.

Approved: ____________________
Arnold W. Frutkin, Chairman

cc:
PCG Working Group Chairmen

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

July 9, 1968

MEMORANDUM

TO : Members, Planning Coordinating Group

FROM : Chairman, Planning Coordinating Group

SUBJECT: Minutes of PCG Meeting July 2

Attending: Cohen, Downs (for Howard), Doyle, Fleming, Frutkin, Scherer (for Donlan), Thome

Absent : Barritt, Malaga, Stroud, Wisniewski

Agenda

Items discussed were the status of Synthesis Group activities, the relationship of the Program Memorandum (PM) to the Planning Source Document (PSD), the status of the AMS procedures draft, and the provision of C of F material to Code BX.

1. Format of PM's - Further guidance will be provided shortly to the Chairmen of the Working Groups.

2. C of F Data - the Program Category Working Groups are expected to identify project-oriented facilities requirements when they develop resources requirements in their PSD's and PM's. These will be made available to Code BX. Other types of facilities (institutional, general purpose technology enhancement, etc.) will more likely come to the attention of the Institutional Working Group. Mr. Donlan and General Curtin are asked by copy of these minutes to coordinate on this point.

3. Planning Source Document - The Group's conclusions on the preparation and duplication of the PSD are contained in a separate memorandum from the PCG Chairman to Working Group Chairmen.

4. External Access to Planning Documentation - This question will be placed on the agenda of the next PCC meeting and discussed in advance with Dr. Newell, Mr. Allnutt, and Mr. Scheer.

AWF

Arnold W. Frutkin

cc:
Working Group Chairmen
E./Curtin
MDT/Donlan

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

July 9, 1968

MEMORANDUM

TO : Members, Planning Coordinating Group

FROM : W. G. Stroud, Acting Secretary

Subject: Minutes of PCG meeting, 9 July 1968

Attending: Messrs. Chatham (for Wisniewski), Donlan, Downs, Doyle, Fleming, Frutkin, Stroud, and Thome

Absent: Messrs. Barritt, Cohen, and Malaga

Agenda

1. Availability and distribution of planning documents to external groups.

2. Discussion of PSG meeting for July 23-24.

Decisions

1. Since the Program Memoranda and the supporting Planning Source Documentation (PSD's) of each Working Group will contain budgetary data for FY 1970, these documents can not be made available to external groups until the President submits his budget message. In addition, PSD's are supporting documentation to PM's and, as such, are internal documents not properly available to groups outside the Agency.

Actions

1. Cognizant PCG members are to keep tab on progress of WG's in meeting July 15 deadline for sending draft PM's to PSG members.

2. Working Group Chairmen will be sent the agenda for the PSG meeting of July 23-24 indicating role of WG Chairmen at meeting and the desired ends of the meeting.

Approved:______________________________
Arnold W. Frutkin, Chairman

cc:
Working Group Chairmen

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

July 31, 1968

OFFICE OF THE ADMINISTRATOR

MEMORANDUM

TO : DISTRIBUTION

FROM : AA/W. G. Stroud, Secretary, Planning Coordinating Group (PCG)

SUBJECT : Minutes of Planning Coordinating Group, 30 July 1968

Attending: Thome, Cohen, Barber, Fleming, Scherer, Fosque, Chatham, Doyle, Downs, and Stroud (Acting Chairman)

Agenda:

1. PCG Members comments on Planning Steering Group (PSG) Guidance Paper of 26 July.

2. Discussion of Dr. Paine's FY 1969 Budget Meetings; preparation by PCG for Planning Steering Group.

Decisions:

1. Discussion of the FY 1969 Budget Meetings revolved around the questions of whether the Agency was carrying out three parallel budgeting exercises, i.e., by Code B, by Program Office and by PSG/PCG, and whether or not there was anything PCG might do to prepare responses to the issues identified.

It was the consensus of the Group that:

a. The different budget activities represented different points of view; presumedly the base data would be the same, therefore they would converge.

b. The PCG could not do anything specifically vis-a-vis the 5, 6 August meetings, but that AA Staff should prepare any PSG/PCG responses to the issues raised.

Actions:

1. Review of the 26 July Guidance Paper from PSG to the Chairmen of the Working Groups, in which it was clear that the Working Groups could not meet the 2 August deadlines for revised draft PM's, resulted in the Chairman asking Code PT to review the initial drafts for suitability for transmittal to BoB to meet the 31 July deadline and to consult with Code P on the procedure and desirability of sending the initial drafts.

2. The Chairman agreed to ask Codes S and MD to resolve the question of where science and applications budget line items for experiments flown in manned systems would be shown. The alternatives seem to be in the program category (discipline) budgets as additive and in OMSF and LE as non-additive or vice versa.

WAP

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

August 14, 1968

MEMORANDUM

TO : Members, Planning Coordinating Group

FROM : P/Assistant Administrator for Program Plans and Analysis

SUBJECT: Minutes of PCG meeting of August 14.

Agenda:

1. Schedule of NASA Planning System activities for August and September.

2. Status of PMs

3. Status of Synthesis Activities

Decisions:

1. Final PMs and PSDs are to be finished by September 3. Each Working Group is responsible for distribution of the PMs on September 3 or earlier where possible. A complete distribution list will be provided shortly. The PSD of each Working Group, as the necessary back-up data to the PM, should also be available at this time, but requires no distribution.

2. Due to the nature of the Space Applications Program Category, this Working Group will be provided an hour presentation at the PSG meeting of September 3 and 40 minutes at the A/MC meeting of September 9.

D. D. Wyatt

cc:
Working Group Chairmen

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

September 10, 1968

MEMORANDUM

TO : Members, Planning Coordinating Group

FROM : Chairman, Planning Coordinating Group

SUBJECT: Minutes of PCG meeting of September 10, 1968

ATTENDING: Frutkin, Cohen, Barritt, Chatham, Lord (for Donlan), Howard, Fleming, Wyatt, Doyle

ABSENT: Thome and Malaga

Agenda

1. Preparation for transmittal of PMs to BoB

Actions

1. Cognizant PCG members are to insure that Working Group Chairmen send copies of up-dated vugraphs from PSG meeting of September 3 and 4 to Code P/Wyatt by Friday, September 13. These up-dated charts will serve as a summary of the PM and will be placed on top of each PM before transmittal to BoB.

Arnold W. Frutkin

NOTE: To assist in the updating of the charts, attached are notes from the PSG meeting of September 3 and 4.

cc:
Working Group Chairmen

Attachment:

PSG Notes for Working Groups
Meeting of September 3-4

Note: The vugraphs used in the September 3-4 presentation to PSG should be perfected as quickly as possible since they will be placed on top of each PM before it goes to BoB.

Manned Flight

1. Break out the detailed composition of the "Maintenance of Capability" item.

2. Clarify the relationship of the "Maintenance of Capability" item to support of other programs.

3. Assure consistency between numbers, especially in FY '70 decision-point costs, among maintenance of capability, Saturn 1-B costs, and Synthesis numbers.

4. Check any double bookkeeping for experiments item. (Show experiment costs not elsewhere covered; show any experiment costs included in other Working Groups in parentheses.)

Lunar Exploration

1. Review Working Group options to assure one-for-one relationship with Synthesis options.

2. Make clear (a) inclusion of baseline in all options, and (b) time phasing with earth orbital program.

Planetary

1. Eliminate background material, (e.g., relating to goals and the WG process) and focus more sharply on FY '70 decisions.

2. Conform Working Group and Synthesis numbers and dates.

Applications

1. Clarify nature and date of decision points on ERTS, etc.

2. Clarify phasing of options.

3. Provide additional chart to show the feasibility of supporting and carrying out a substantially expanded applications program (in terms of type of effort with reference to the PPB System and number of people required).

4. Show baseline.

Aircraft Technology

1. Clarify any contradiction between the Proof-of-Concept approach and more extensive hardware projects. Consult with Lundin and Meyers regarding the charts concerned.

Space Technology

1. Red-line the option which would delay the final phase of SNAP 8 one year.

2. The low-cost vehicle project appears to consist only of the development and test of the large solid; where is provision made for a broader low-cost vehicle project?

3. Specify some key development areas, e.g., water recovery, two-gas systems, etc.

Institutional Working Group

1. Operate on the basis of the following dual functions:

(a) develop the Group as a long-range tool;

(b) provide material for the current budget exercise along the following lines:

(i) an order-of-magnitude review looking for gross mismatches, booby traps, etc.

(ii) search out implications of cooperative programs

(iii) time-scale for this effort is September 1968.

Space Physics

1. Change the language which describes options as "desired, reduced, minimal, etc." to high, middle and low.

2. Modify decision charts to reflect implications more effectively.

3. Work with Mr. Nicks to revise other elements of the presentation and vugraphs.

Astronomy

1. Show the Astra decision point and the follow-on decision points it opens up.

2. Assure conformity between Working Group and Synthesis exercise.

3. Work with Mr. Nicks on general modification of presentation and vugraphs.

Space Biology

1. Correct title of chart now reading "FY '70 Decisions and Issues."

2. The actual FY '70 decision points and their character need precise identification.

Launch Vehicles

1. Show vehicle costs as Incremental Costs (of one more vehicle) and make it clear if base costs are not included.

2. Develop a chart which shows:

(a) the specific booster,

(b) its non-recurring development cost,

(c) the annual maintenance-of-capability cost (at the appropriate assumed production rate/yr.).

(d) the resulting actual cost of one vehicle launched.

Supporting Activities

1. Meet with Newell, Wyatt, Lesher, and Smith to revise presentation material.

2. Provide for a single presentation of the supporting activities elements.

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